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# The Mass Rearing of the Egg Parasites of the Sugarcane Moth Borer in Mysore.

(*Preliminary Experiments.*)

BY

**Dr. K. Kunhi Kannan, M.A., Ph.D.,**

*Entomologist, Department of Agriculture, Mysore State.*

Since June 1930 preliminary experiments have been in progress in the Entomological Laboratory of this Department to multiply parasites of the sugarcane borer moths with a view, in particular, to the control of the pest and generally to understand the technipue of mass rearing of parasites for the control of pests. The mass rearing of the moth borer parasite Trichogramma has been successfully attempted in the United States and they have been employed there in the control of two pests, *viz.*, the sugarcane borer moth *diatrea* and the codlin moth borer of apples. In Mysore a simple and fairly effective method of the control of sugarcane borer was devised several years ago—the method known as the trash trap method. This while it costs less than Rs. 3 per acre and is fairly effective involves the employment of labour from two to three months during the early growth of cane. The control by parasitic agency would be very much simpler for the ryot, although it involves considerable labour on the part of the entomologist. All that would have to be done

by him would be to release the parasites at the right time and these tiny insects will search out the eggs of the moth borer and breed in them--that is to say, they will lay their eggs inside the eggs of the borer eggs, and their young will thrive on their contents and finally grow into adults which will come out of the eggs ready to attack fresh batches of eggs of the moth borer. The eggs of the moth borer so attacked will, of course, not hatch into borers but into parasites. Apart from that, these egg parasites, as they are called, are somewhat cosmopolitan for they are not very particular about moth borer eggs. Eggs of certain other insects also may be attacked by them. It would be very helpful if the same parasites could be persuaded to attack eggs of other pests in the State for their control also would become easy.

For these reasons it was that the experiments were undertaken. It is necessary to explain before describing the experiments that the parasite of the sugarcane borer exists in the State. In most years when careful search is made during the seasons when the pest is bad, the parasite or parasitised eggs may be found. But they are not usually effective because they do not appear in sufficient numbers to get ahead of the pest. If the pest has had a good start, then the parasites would not be able to check them even though they are numerous. Secondly, even if their appearance is timely they have to be in sufficient numbers. This apparently seldom happens for they have enemies of their own to reckon with. There may also be climatic conditions unfavourable to them and a number of other factors which are not yet clearly understood. To make them effective they should be in sufficient numbers and be present at the right time and for this purpose they have to be reared under favourable conditions. How is this to be effected ?

It is impossible to get the eggs of borer moths in the field in sufficient numbers. They are found largely only between January and May. Rearing them in the laboratory would be tedious and costly as cane will have to be grown for the purpose. Fortunately in America S. E. Flanders found that the parasites could multiply on the eggs of the paddy moth and also on the rice web-worm moth or as it is called the flour moth. These two insects multiply in the stores and can be made to produce eggs in thousands. The paddy moth was tried here first but the eggs did not prove quite satisfactory for

the variety of the parasite found in Mysore although in the United States of America, it is these that are employed. We have not abandoned the hope of rearing the parasite on this moth and further attempts are being made. On the failure of the first experiment, however, attention was turned to the flour moth and the eggs of the moths were readily accepted and healthy parasites were reared out. One generation of the parasite takes from 6 to 11 days and we have reared over 32 generations till now.

As regards the rearing, attempts have been made to simplify the procedure adopted in the United States. There, these moths multiply in shallow vats containing corn placed in shelves. The moths emerging fly out and settle on the walls of the rearing room as they do in paddy stores here and they are collected by means of a vacuum pipe into jars. These are then divided into lots. Each lot is placed in a circular box with wire bottom which stands over a funnel fitted to the mouth of a jar. The moths lay eggs through the wire gauze which drop into the funnel from which the eggs are collected and cleaned. The eggs are then dropped on paper discs with a coating of gummy varnish so as to attach them to the surface. On these egg cards placed in petri-dishes, parasites are introduced. When they have parasitised the eggs, the petri-dishes are placed in a refrigerator until they are required. If this is not done the parasites would emerge in the usual course in about 6 to 11 days but when kept in a refrigerator they cease to develop on account of the cold. But as soon as they are removed development starts again and is soon completed. The refrigerator therefore helps to keep the parasites for use until they are required. Now this method of rearing is somewhat costly and tedious so far as India is concerned. Collecting many thousands of moths requires time and a vacuum for the purpose requires apparatus. To simplify procedure various experiments were made and one of these appears to be promising. In the tin cylinder in which the web-worm is reared a roll of a strip of corrugated packing paper one inch wide is placed so as to closely fit into the surface of the grain. The caterpillars work their way up to the surface for pupation. When they find the spaces in the roll of corrugated paper they enter those and pupate there. When a good number has pupated the roll is taken and fitted to the mouth of a small cylinder *upside down*. This turning is necessary for the caterpillars pupate with the

head upwards. In turning the roll upside down the pupæ will have their heads directed downwards. On emergence, therefore, the moth will fly into the cylinder. There they pair and lay the eggs for whose reception a funnel fixed on to the mouth of a cylinder is provided below the wire gauze bottom. This and the subsequent processes are much the same as those followed in the United States of America, with this difference that for pasting the eggs on the cards we use the mucilage from cactus which is cheap and very effective.

We have reared several thousands of parasites and parasites have been released on the cane at the Government Farm in Hiriyur. The results of this are awaited.

During the year we have had opportunities of testing the parasites we have been rearing against the eggs of the following pests :—

1. Euxoa sp.
2. Heliothis obsoleta.
3. Amsacta albistriga.
4. Diacrisia obliqua.
5. Laphygma exigua.
6. Adisura Atkinsoni.

These trials were made in the laboratory. How far they will prove successful in the field remains to be seen. In the case of Diacrisia obliqua it was found that several parasites emerged with ill-developed wings. Against this pest at least the parasites may not prove effective but against others field trials will be made as opportunity occurs. If at least against some of them the parasite proves successful the idea with which the mass rearing of the parasite was attempted will have been abundantly justified.

One thing is certain. To the ryots the control of sugarcane moth borer would become very easy, much more easy than it is under the present trash heap method. When the mass rearing is begun and systematised, all that they would have to do would be to ask for parasite cards as soon as the canes have sprouted and then distribute small pieces of cards all over the field pinned on to cane leaves. The parasites when they emerge will seek out the eggs of the moth borer and multiply in them and will be ready to attack in large numbers as the season advances and more borer moth eggs are laid on the crop. Insects will thus be made to control insects as sometimes thieves are set to catch thieves.

Before concluding it is necessary to emphasise that the rearing conducted has been of an experimental character. The methods employed hitherto while satisfactory may have to be superseded and we may have to resort to eggs of the paddy moth (Sitotroga cerealella) if we can get them to produce eggs more satisfactorily to Trichogramma. We say so because there are some inconveniences arising from the webbing habit of the flour moth worm, for not only is the rice from which they are reared unsatisfactory for resale but on the egg cards some of the eggs left unparasitised hatch into caterpillars which may eat up several of the parasitised eggs and what is worse, web up the surface of the egg card hindering the escape of the parasites. On the other hand, the grain from which the paddy moth is reared is resaleable without difficulty and the caterpillars have no webbing habit. But the trouble has been that the eggs do not appear to be big enough. These difficulties have to be got over. As regards the rice web-worm various materials are being tested for rearing and of these broken cotton seed appears to be the cheapest. In all these respects further trials will have to be made. Before this is done the results obtained cannot be said to be final and the method employed the best possible, though it has the merit of being cheaper than the one followed in the United States.

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## Thirteenth Annual Meeting of the Mysore Agricultural and Experimental Union, 1931.

### Speech by Dr. Leslie C. Coleman, M.A., Ph.D.,

*President of the Union.*

YOUR HIGHNESS, MR. D'SOUZA AND GENTLEMEN,

The next item on the programme to-day is the reading of the Annual Report of our Secretary. It will give you a statement of the work that has been done during the past year. It seems to me however fitting that I should tell you something about the activities of the Union from its inception. This Union was organized in the year 1918 with the primary object of bringing former students of our Agricultural School who have returned to the land, and leading agriculturists in the State who are interested in agricultural improvement, into closer association with the State Department of Agriculture. The main object of that association was to enlist the co-operation of these

gentlemen in carrying out co-operative experiments all over the State, to test the recommendations of the Agricultural Department with special reference to their suitability to different areas. That object, I think we can say, has not been fulfilled as fully as we had originally anticipated. I suppose that is invariably the case when a lot of enthusiastic young men get together and plan for the future. They usually anticipate something very much better than actually occurs. Nevertheless, I think, we can say that there has been steady improvement in this regard. Now the Union has done much more than this. It has in its annual meetings interested itself in the discussion of the larger questions on agriculture and I think I can say that it has taken a leading part in the inauguration of certain schemes in the State which, had this Union not existed, would probably have never been started at all. Perhaps the one scheme which has received more publicity than any other has been the scheme of agricultural colonies. As you know, this scheme was first mooted by this Union many years ago and has become an accomplished fact within the last year. That colony has been organized and has made a satisfactory beginning under the Bhadra Channel. I am not yet prepared to say to what extent that scheme will be successful, but I can say, considering the present financial condition, the scheme has been started promisingly.

Another scheme which was first discussed by our Union and which has recently received the approval of Government in somewhat modified form is the scheme for the better utilization of *gomal* lands. An interesting discussion of this subject took place in more than one of our meetings and it was then decided that something should be done to improve the conditions of our grazing lands which, as everybody knows, are almost useless. Government have recently approved a tentative scheme for starting experimental work in certain favoured villages for turning over the gomal land to the villagers with the object of growing fodder crops. There are other important schemes sponsored by the Union which have not yet received attention but I trust they will receive the attention of Government as soon as our financial condition becomes normal.

Government have given definite recognition to the value and importance of this Union by appointing to the Agricultural Board a member representing this Union. More than this, His Highness

the Maharaja of Mysore has been graciously pleased to give very signal recognition to a few prominent individual members of this Union for the work that they have done. I mention a few names here —Mr. N. Krishna Iyengar, Mr. B. Sreenivasa Iyengar, Mr. McIsaac, Mr. Laxmana Reddy of Sabbanahalli, Mr. Venkataswamigowda and others. This shows the sterling qualities of these gentlemen who have helped by their work this Union in particular and agriculture in general. I believe in every case this distinction has been conferred upon them for agricultural work or other work associated with agriculture such as co-operative work.

Now, gentlemen, our organization is but one of many in the State. It is no secret to you probably that the development departments in the State will, during the next year and probably during some of the succeeding years, not receive those grants of funds which they have received during the last few years. It seems to be a matter of great import at the present moment when the whole of our agriculture is in a depressed condition. I should feel myself to-day in an extraordinarily pessimistic mood were it not for the one fact that I see development in this State not only among those Government departments which are concerned with the agricultural development but also between the Government departments and non-official organizations of a spirit of co-operation which has not existed in the past. I have on more than one occasion stressed the point that if our funds are to be restricted as seems inevitable it places upon us a more solemn duty that the funds that have been provided to us should be utilized to the very last pie in the most economical manner possible. Everybody knows that there are many departments and private organizations which interest themselves in one way or other with the raiyat. Some of these interests, I think, the raiyat may consider as not directly to his benefit. The Revenue Department has, among its duties, a number of activities which are directly concerned with the improvement of rural conditions. The Department of Co-operation and the Department of Industries and Commerce also touch the life of the agriculturist at very many points. So also the Department of Education. An effort has been made during recent years to bring about a much closer association between most of these departments than had existed before. I wish here to lay

stress on the fact that the relationship between these departments is of a more cordial character in the present moment than it has ever been during my service of 24 years. That is partly due to the fact that the heads of these departments meet together regularly in a way that ten years ago was unknown. As you may be aware a special Development Committee consisting of the heads of departments I have mentioned and the Development Secretary to the Government has been formed. This Committee meets ordinarily once a month to consider important questions connected with agricultural development and has already submitted a very considerable number of important proposals to Government. The presence of the Development Secretary on the Committee enables us to keep in touch with the views and decisions of Government in a manner that would be otherwise impossible. May I point out to you that during the last year one matter of very great importance to the agriculturists of this State has been considered by that Committee and definite action has been taken? I refer here to the establishment in the Department of Industries and Commerce of a special section to deal with the manufacture of agricultural implements both for testing purposes and distribution purposes. Recently the orders of Government for the organization of that special section have been received and two days ago I had an interview with the gentleman that has come here to supervise the work. Action has already been taken and I trust that in a short time we shall be able to place in the hands of the members of this Union and other agriculturists, ploughs as efficient as any of those that have been sold, at a very greatly reduced rate. In addition to this, it has been decided to help the village blacksmith so that he can take up the manufacture of this implement in a much more efficient way by furnishing him with the material which will enable him to make an efficient implement. I have always been particularly keen on the development of any possible scheme towards the development of village industries and this seems to be a particularly promising one.

I might mention as another instance of closer co-operation the very marked increase of interest of the Village Panchayats in agricultural improvement. That is largely due to the initiative of my friend Mr. D'Souza and of the present Revenue Commissioner Mr. Rajagopalachari. I have not the actual figures at hand but I

think it is safe to say that during the past year notwithstanding the difficult conditions through which we are passing there has been a doubling of the number of Village Panchayats who have taken practical interest in the development of agriculture. In two such important subjects as agricultural co-operation and agricultural education, it is perfectly obvious that close association between the departments is essential if money is to be spent wisely and economically. As regards the relationship between the Co-operative Department and Agricultural Department, it has been for many years of a most intimate and cordial nature. I wish here to pay my special tribute to my friend Mr. Ramiah to whose sympathy and enthusiasm this co-operation is largely due.

Gentlemen, I return to the activities of the Experimental Union. There is one other activity which I have not mentioned and which is of increasing importance. I refer to that activity which has to do with the dissemination of agricultural knowledge. As all of you are aware, we publish now, with fairly commendable regularity, an English Journal and, what is more important still, a Kannada Journal. That Journal was intended primarily as a means of giving to the public the results of the operations of this Union but it is now becoming more and more the mouthpiece of the Agricultural Department to the public of Mysore. The success of this Journal is mostly due to the cordial sympathy and co-operation of the Revenue Commissioner and the Director of Public Instruction. The Kannada Journal is being increasingly introduced into the Village Panchayats of this State and into the Middle Schools as well. Very much remains to be done in this regard. The total number of Village Panchayats is, I believe, something like 9,000, and though there has been a marked increase still only a small number of them are really getting the Journal. As regards Middle Schools we have a very long way to go before we can reach them all but it is satisfactory to note that although we have not reached that goal we are on the way. May I again remind you and all those that are interested in agricultural development in the State that although something has been done in the way of co-ordinating our activities, unless we devote serious attention to this subject and put forth much more strenuous efforts than we have in the past, improvement of agriculture is going to be a very serious affair. I think it must be known to everybody that

some of the non-official gentlemen who represent in the Legislative Council and Representative Assembly have said at various meetings in the State that a large amount of money at the disposal of the various departments of Government is wasted. Gentlemen, I am not prepared to accept that statement but I am prepared to admit that there is a waste. I believe that some of that waste is unavoidable in this life of imperfection. I have not yet met one who is able to utilize always funds, whether ancestral or placed at his disposal by the benign Government for work, fully to the very best advantage. But I still believe that there is a good deal of overlapping in regard to definite work on the improvement of agricultural population which can be avoided and I believe the closer association to which I refer will lead to a considerable reduction in the amount of such waste. In this way to a very great extent we should be able to counteract the reduction in allotments which is inevitable.

There are a number of organizations in the State which have to do with agricultural improvement. The most important of these, as regards the future of agriculture, is undoubtedly the District Board. The District Boards as you know during the last year have undergone a change and have become entirely non-official organizations. Their interest in agricultural development has been steadily increasing. Even this year when the funds placed at their disposal have been limited, there are indications of increased interest in the improvement of agriculture. The Boards of Districts possessing agricultural schools are contributing liberally towards agricultural education and one District Board is practically running the agricultural school. The increased veterinary aid and improvement in live-stock would hardly have been possible had it not been for the keen interest evinced by the District Boards in these subjects.

Now, gentlemen, I have referred in brief to the various activities of this Union and of other organizations in the State and I personally wish to use my best efforts during the coming year towards bringing about an increase of these activities. I wish now to refer to a subject which has not yet received the attention of this Union or, as a matter of fact, that of the Agricultural Department. I am not one of those who believe that there is any panacea for the depressed agricultural conditions that exist in this State and as a matter of fact, throughout the whole world to-day. No panacea has been discovered in any

country and I must remind you that other countries are quite deeply concerned with this question as we are. I need only to refer here to that country which has been held up for so many years as a model in Mysore. I mean the United States. You will find thousands of farmers destitute and many millions out of work and wandering about trying to find it. Notwithstanding the fact that there is no panacea for the present, I believe there are certain things we can do here to help the agricultural situation. We should be able to lessen the charges involved in the distribution and marketing of agricultural produce and thus enable the agriculturists to get prices for their produce more closely related to the prices paid by the consumers. The question of distribution of agricultural produce is very largely a world question, but undoubtedly improvements in marketing conditions are possible and these will lead to some improvement in agricultural conditions. I believe these are questions which the Union should take up for serious consideration.

As you are aware this Union has in the past excluded from considering all subjects with a political bearing. There was, it was true, some years ago a proposal that we should seek for representation in one of our popular houses, the Representative Assembly, but that proposal was rightly vetoed. Had we taken up the consideration of political subjects it would have been difficult, if not impossible, to have maintained that close association between the Union and the Agricultural Department which now exists.

I am not prepared to state that with the changed conditions which all of us see ahead it will be advisable for us to change our policy in this regard. But I do believe that a very real need will arise in Mysore as in other parts of India for the establishment of an organization which will be able intelligently to voice the real needs of Indian agriculture divorced from all questions of community or caste.

It seems quite clear that we shall in the not distant future find ourselves faced with a demand for high tariffs to protect a large number of existing or prospected industries in this country. We have this view voiced by leaders such as Mahatma Gandhi on the one side and the Right Honourable Srinivasa Sastry on the other. I have yet to see any serious consideration of how such a policy is likely to affect our greatest industry of all, agriculture. I am neither a politician nor an economist but it seems to me as plain as day that at least during

the period of industrial development the cost involved in bringing industries to a state of efficiency will fall almost entirely on the agricultural population—a population which we are assured on all sides is already ground down to the lowest depths of poverty. We may possibly consider that this will be a temporary phase and that the increased prosperity of the country due to the development of industries will react favourably on the country's agriculture and more than make up for the temporary burden which has been placed upon it. Looking at the condition of the agriculturists in a country like the United States I can personally see little ground for this hope. for the agriculturists of that country have been and are still being sacrificed on the altar of industrial development. A huge industrial organization has been built up under the shelter of protective tariffs and that organization seems now largely to control the Government policy, certainly not to the benefit of the nation's agriculture. It may to many seem fantastic to visualize a time in this country when similar conditions will exist but no doubt the people of the United States of one hundred years ago would have looked upon such a vision as equally fantastic. In any case it seems to me very necessary to sound a note of warning to agriculturists throughout India of the danger lurking in the future before them.

I think I may safely say that the agriculturists lack many real leaders who understand the agricultural conditions. Unless we develope the real spirit of interest in agriculture which after all is the basic interest, unless we develope here in Mysore and in other parts some body of public opinion which is interested in the raiyat as a raiyat and for no other reason, I fear for the future. I can assure you, gentlemen, that my whole life has been wrapped up in that one thing - the development of Indian agriculture.

Before closing my remarks I wish to refer here to a subject which I am sure will fill many of you with regret. As you know Major Simpson has been a very active member of this Union from its inception. Few men, I believe, have done more permanent good to the raiyat population of the State than Major Simpson has. He is leaving us retiring to his native land. I think you would all wish to join with me in wishing him many years of happiness in his retirement which he has earned. When I retire, if I can look back upon a career as Major Simpson can look back to-day, I shall be happy.

## Annual Report.

### By the Secretary.

It gives me great pleasure to welcome you to the Thirteenth Annual Meeting of the Mysore Agricultural and Experimental Union.

A statement showing in detail the progress in membership as well as work done by the members is appended.

#### Results of Experiments.

Seasonal conditions have been generally favourable during the year although there has been a fair number of failures of dry crop experiments, and tank-fed paddy—both varietal and manurial.

Material was supplied by the Department for the following experiments. Results have been received as mentioned in the statement.

Seeds :—

| Varieties | Number of Experiments. | Reports received. |
|---|---|---|
| Ragi .. | .. 33 | 22 |
| Groundnut .. | .. 27 | 19 |
| Paddy .. | .. 40 | 23 |
| Sugarcane .. | .. 21 | 11 |
| Manures :— | | |
| Paddy .. | .. 29 | 22 |
| Sugarcane .. | .. 19 | 8 |
| Total | 169 | 105 |

#### Ragi Varieties.

The improved varieties have done well generally throughout. H2 and H40 have yielded better than local in the two experiments near Hassan. At Holalkere H40 has given the best yield. At Banasandra in one of the two experiments, each of the three improved strains H40, H2 and H22 supplied has yielded almost twice as much as local. In the other experiments H22 and H40 have done best. At Siddlaghatta H2 and H40 have given as much as local. At Challakere, the local variety (unnamed) has done distinctly better than the improved strains, H40 coming close to it.

### Groundnut Varieties.

H. G. No. 1 was the only variety supplied for trial. At Holalkere Small Japan has yielded one and a half times as much as H. G. No. 1. The poor yield of H. G. No. 1 is attributed to failure of rain. In other experiments H. G. No. 1 has yielded either less or more than the local which is not named. If the local were a spreading (long duration) variety the better yield from it is natural.

### Paddy Varieties.

G. E. B. 24 was the only variety supplied for experiment. Excepting in one instance this variety has yielded better than the local variety. G. E. B. 24 was later than the local by 20 days at Anekal and 40 days at Challakere. This point has not been reported upon from other places.

### Sugarcane Varieties.

H. M. 320 has done the best wherever tried against the local and other improved varieties. H. M. 544 striped has done the best at Sabbanahalli but unfortunately H. M. 320 was not included in the experiment at this place although it was available with the member. At Vatadahosahalli, Goribidnur, H. M. 320 has given 34 maunds more jaggery per acre than Pattapatti. At Sonaganahalli, Goribidnur, it has given 135 maunds jaggery more than Pattapatti which has given a very poor yield. At Kalludi, Goribidnur, H. M. 320 has given 40 maunds more jaggery than Pattapatti. At Siddlaghatta it has given 36 maunds more than H. M. 500, another improved cane but here the local variety was not included in the experiment.

### Manurial Experiment.

Sugarcane manurial mixtures applied to sugarcane have increased the yield of jaggery by 17 maunds in one instance and 40 maunds per acre in the other. On the third experiment there is an increased weight of 5½ tons of cane per acre.

### Paddy.

Of the manures tried on paddy, Nicifos No. I with groundnut oil cake has given better results in three experiments, the increase over check plots being from 4 to 8½ pallas of paddy. Nicifos II has given better yield in two cases. Ammophos 13/48 grade with groundnut

cake has given the best results in another case. Wherever the supply of irrigation water was not dependable, the manurial experiments were either not tried at all or where tried and failed.

The reporting of results is yet not satisfactory. Out of 169 experiments of all kinds for which material was supplied only 105 reports of either success or failure have been received. No information is available as regards the rest. Even the reports received, excepting in a few cases, are very defective. Very little information is furnished. The forms on which reports should be made are not used although specially supplied. Much effort on the part of the Union is wasted on account of non-reporting and defective reporting.

### New Kind of Share for Satara Plough.

As one of the complaints made by the members with regard to K. M. type of Satara plough was that the share was of inferior quality, the Cooper Engineering Works supplied what they call "Heavy Alloy Chilled Cast Steel" shares for trial. These were sent out to eight members last season but as the ploughing season was over when the shares reached them the members are trying the new shares during the present season.

### The Hassan Branch Union.

The Hassan Branch has very few members now, the old members having dropped out by not paying their annual fees. But experimental work is being done by the few members who remain. The largest number of experiments in any one Range during the year was done in the Hassan and Saklespur Ranges. Special fieldmen were appointed by the Union for three months to help the Agricultural Inspectors in collecting results. The experiments in the Hassan Range were correctly laid out and results reported promptly.

### Affiliated Association.

The Kolar District Agricultural Association applied for affiliation to the Union. A special General Meeting was held on the 15th November 1930 to decide upon the conditions under which local Agricultural Associations might be affiliated to the Union. The rules approved by the General Body were communicated to the authorities in Kolar.

### Village Crop and Cattle Show.

Our Vice-President, Mr. B. Sreenivasa Iyengar, conducted a unique kind of village show in his Jodi village of Adur. It was an exhibition at the harvest time by his tenants of the very best of the crop they had grown and cattle they had reared. Improved varieties of Ragi, Groundnut, Paddy and Sugarcane were exhibited side by side the local crops. Rural shows such as the one arranged by Mr. Sreenivasa Iyengar are of great use in stimulating interest in improvement among the villagers. Mr. Sreenivasa Iyengar has set an example to Jodidars and Village Panchayats, which deserves to be emulated.

### Journals of the Union.

The Journals continue to be popular. The English Journal due to slow availability of contributions, does not issue regularly once in a quarter. The Kannada edition, which is a monthly, has therefore to be kept uptodate, by writing special articles to its pages. Five English numbers and fifteen Kannada numbers have been issued since the last Annual Meeting. The articles appearing in the Kannada Journal are largely reproduced in their pages by the local vernacular papers.

Thanks to the efforts of the then Revenue Commissioner, Chairman of this meeting, 155 Village Panchayats have been subscribing for the Kannada Journal. But as compared with the number of Village Panchayats in the State, the number which are subscribing is exceedingly small. Unless the local officers who exercise control over the Panchayats interest themselves more than now in the spreading of useful knowledge by popularizing vernacular journals such as ours, propaganda through the printed page is likely to achieve little. Instructions have been sent by Government, the Revenue Commissioner and some Deputy Commissioners to the effect that Kannada Journal should be popularized among Village Panchayats. But these instructions seem to take an unduly long time to reach the destination and lose considerable force when they do. The Director of Agriculture has personally written to all the Amildars. Excepting among the Mysore and Kolar Districts, the response has been rather disappointing. The following Amildars have been taking special interest in popularizing the Kannada Journal :—

| | No. of copies subscribed. |
|---|---|
| Chamarajanagar .. .. | 30 |
| Heggadadevanakote .. .. | 15 |
| Gundlupet .. .. .. | 15 |
| Gudibanda .. .. .. | 14 |
| Mulbagal .. .. .. | 12 |
| Harihar .. .. .. | 8 |
| Sagar .. .. .. | 6 |
| Yelandur .. .. .. | 5 |
| Thirthahalli .. .. .. | 5 |
| Seringapatam .. .. .. | 4 |
| Bagepalli .. .. .. | 4 |

The thanks of the Union are due to all these Officers.

The Annual Field-Day of the Union was held on the 15th November, 1930. Non-official members attended it in large numbers. A small cattle show and a crop exhibition were held on the same day. Srimati D. Sakamma awarded a gold medal for the best live-stock exhibit as in previous years. Prizes were awarded by Mr. W. Smith, Imperial Dairy Expert, Mr. B. Srinivasa Iyengar, our Vice-President and Dr. Coleman. The thanks of the Union are due to all these gentlemen and Srimati Sakamma.

The statement of receipts and expenditure is appended.

STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING 31ST DECEMBER 1930.

| RECEIPTS. | RS. | A. | P. | EXPENDITURE. | RS. | A. | P. |
|---|---|---|---|---|---|---|---|
| Opening Balance .. | 1,818 | 4 | 8 | Establishment .. .. | 1,616 | 9 | 6 |
| Admission Fee .. | 194 | 0 | 0 | Printing .. .. | 1,525 | 2 | 0 |
| Annual Fee .. | 830 | 8 | 0 | Annual Meeting Expenses (for 1929 & Field Day) .. | 403 | 15 | 6 |
| Subscription .. | 693 | 4 | 0 | Postage .. .. .. | 81 | 0 | 0 |
| Miscellaneous .. | 38 | 1 | 0 | Miscellaneous | | | |
| Subvention .. | 2,500 | 0 | 0 | (Stationery, Furniture, etc.) .. | 92 | 2 | 0 |
| | | | | TOTAL .. | 3,718 | 13 | 0 |
| | | | | Cash on Hand .. .. | 2,355 | 4 | 8 |
| GRAND TOTAL .. | 6,074 | 1 | 8 | | 6,074 | 1 | 8 |

## Statement of Receipts and Expenditure from 1st January to 30th April 1931.

| Receipts. | Rs. | A. | P. | Expenditure. | Rs. | A. | P. |
|---|---|---|---|---|---|---|---|
| Opening Balance.. | 2,355 | 4 | 8 | Establishment .. .. | 732 | 14 | 10 |
| Admission Fee .. | 33 | 0 | 0 | Printing .. .. .. | 530 | 12 | 0 |
| Annual Fee .. | 221 | 0 | 0 | Annual Meeting Expenses (for 1929 & Field Day) .. | 58 | 6 | 4 |
| Subscription .. | 336 | 8 | 0 | Postage .. .. .. | 32 | 8 | 0 |
| Miscellaneous .. | 1 | 8 | 0 | Miscellaneous (Stationery, Furniture, etc.) .. | 28 | 2 | 0 |
| | | | | Total .. .. | 1,382 | 11 | 2 |
| | | | | *Cash on Hand .. . | 1,564 | 9 | 6 |
| Grand Total .. | 2,947 | 4 | 8 | Grand Total .. | 2,947 | 4 | 8 |

* Printing Bills paid subsequently.—Rs. 800 0 0.

## Opening Speech.

BY

**Rajakaryapravina P. G. D'Souza, Esq., B.A., B.L.,**
*Member of Council.*

GENTLEMEN,

It is a great privilege to take part in the proceedings of an Association such as yours, consisting, as it does, of our most prominent agriculturists whose object is to devise the best means of improving the agricultural position in the State. One of the chief causes which prevent active co-operation between the technical Government Departments and the people whom they are intended to serve, is the feeling that the former occupy a higher pedestal and the success of your work is due to the elimination of this feeling and the genuine spirit of *camaraderie* that knits both the officials of the Department and the agriculturists. The existence of this spirit is primarily due to our popular Director of Agriculture, Dr. Coleman, who considers his chief duty to be to guide the people in improving their resources and create in them a feeling of the utmost reliance on and confidence in the Department. Many Government officers spend laborious days over their work, but measured by its utility to the people, the results are not satisfactory owing to the lack of a determination on their part to direct their intelligence and energy primarily into channels of benefit to the people. I am glad, however, that, as far as the Agricultural Department is concerned, it can proudly say that neither in the choice of its work nor in its dealings with the people has it been inspired by any other ideal than the increase of agricultural production and its resultant advantages.

2. A witty Finance Minister once described the Indian Budget as a gamble in rain but this typifies the normal condition of our agriculturists. Except in the case of irrigation channels drawn from rivers or of parts of the State where the monsoons are copious, no one can have any certainty when he sows the land that the rains will be propitious. This makes the position of agriculture in Mysore seldom free from anxiety and is one of the greatest obstacles in the way of farming so as to yield the maximum return. Unless there is total failure of rains, science can, however, still greatly help the agriculturists to improve the return from the lands. Application of manure of the proper kind in sufficient quantities, selection of proper seed,

use of improved ploughs, intelligent pursuit of operations and promoting the growth of crops, proper harvesting methods and marketing are some of the ways in which the profits from agriculture can be substantially increased. There is no doubt that a great deal has been done in these directions but, as yet, so far as the bulk of the agriculturists are concerned, either through ignorance or poverty or want of organization, the total effect of such improvements is on the whole not very remarkable.

3. If you take statistics, you will find that though there has been a noticeable increase in the area under cultivation and to a certain extent in the growth of commercial crops, the increase in agricultural production as a whole has not kept pace with the increase in other forms of wealth, if we make allowance for the large development in irrigation. Though seasonal conditions account for this to a certain extent, there are many other causes the remedy for which is, to a certain extent, in our own hands.

Some fifteen years ago, an attempt was made to find out methods by which agricultural production could be doubled and Dr. Coleman prepared a very interesting note on the subject. The possibility of dramatic changes in the productive capacity of a country has obtained much publicity by what is known as the five-year Soviet plan in Russia. Though it may not be possible to adopt such methods here yet it is worth considering how to give special impetus in the State to greater production without undue interference either with the liberty of the individual or vested rights. The main principles of the Russian system seem to be to employ, in the case of agriculture, methods of large-scale production which involve the extinction of all private rights and use the produce for payment for machinery and development of industries. The great fall in the price of wheat is attributed to this action of the Soviet and every country is considering how to protect itself against this outpouring of surplus foodstuffs. The chief reason why our agriculture is so backward is that our holdings are so small. With the limited size of our holdings, there is great difficulty in economising labour, in introducing efficient methods of cultivation and harvesting and attracting capital on a sufficient scale. Unless, therefore, the problem of the consolidation of holdings is solved in a satisfactory manner, any marked increase in production cannot be planned. There are no doubt serious difficulties in achieving

any such result. Our system of land tenure, proprietory right and even social and political ideals are opposed to it but so long as we fail to educate the public in the necessity for this change and create an organization to give effect to it, all other methods of agricultural improvement will only be partially successful. If in Russia by a single ukase of the Government private property can be abolished and all the land is cultivated as if it formed a single estate, is it impossible in India to make a beginning and collect together a band of public workers to propagate the movement for consolidation of holdings ?

4. It is very often the misfortune of the Agricultural Department that it is blamed for not being able to show any great increase in agricultural production when the causes are not entirely in its control. The Department may be able to give the best advice in regard to the implements to be used, supply excellent seed, put the people in touch with suppliers of manure and help them as regards harvesting and preparing agricultural products for the market, but all this requires capital and no one has been able to find a proper solution for this great problem. It is true that the co-operative movement has been of some assistance in this direction but from a calculation I made some time ago, the Co-operative Societies are not able to supply even 5 per cent of the capital required by agriculturists even with the primitive methods followed by them. Their other great difficulty is the harvesting and marketing of the produce. Very few of them are able to store the grain so as to be able to sell it when the prices are high and there is no business which has so many parasitic middlemen. It is idle to expect a technical department to do much in the way of direct help to the people unless these three problems are solved. It will be necessary in future greatly to revise our economic ideals in order to produce adequate and continuous development and not leave the poor agriculturist to fight his battle single-handed but help him with all the resources of the State and the people by creating special facilities for supply of capital for agricultural purposes and more efficient marketing arrangements.

5. There is a feeling that agriculture follows its own pre-destined course and much cannot be done to change this. It is true that agriculture seems to pass through regular cycles of prosperity and depression and neither our meteorological knowledge nor economic

investigations have enabled us to understand the causes of this phenomenon. For instance, after a series of very favourable years, we are passing through a period of severe depression when owing to the abnormal fall of prices, even if the harvests are plentiful, the agriculturists are not able to maintain their position. The interest taken in the department is also subject to similar vicissitudes, and while agriculture is more than ever in need of assistance, this is greatly curtailed owing to financial causes when its help would be most useful.

Another thing that greatly discourages our officers of a scientific department is the impatience exhibited at the slowness of results and the want of belief in research. Science does not reveal its treasures without the utmost sacrifice of time and energy. We should therefore foster the spirit of research though the results may be slow and sometimes not very evident. Even in this State, in spite of the small amount spent on research, the Department has been able to show very valuable results by way of discovery of new seed and increased production.

As a result of the recommendations of the Royal Commission on Agriculture, an Imperial Council of Agricultural Research has been organized and the State has been allowed to nominate its representatives to it and participate in the benefits of the researches and investigations inaugurated with its help. We should therefore strengthen our local organizations for research so that, while we obtain their help for the larger problems, we may do intensive work on our local problems. In times of financial stringency, the axe is very often applied to such organizations but having regard to the very important problems now confronting us, *viz.*, improvement of our staple commercial crops, such as coffee, sugarcane and cotton, extensive use of manures, problems of agriculture in special localities, insect pests, fungoid diseases, there should be in my opinion at the present moment the most vigorous pursuit of these problems.

6. India is an agricultural country and for a long time to come is likely to remain so. The bulk of the people will always be dependent on agriculture. There has been a tendency owing to growing unemployment for more and more people to be thrown back on the land and unless the conditions of agriculture are made more and more attractive so as to draw to it larger numbers of educated and trained men, there is little scope to avert the crisis. We have just

made an experiment in the way of agricultural colonies. In my opinion, these schemes will have to be greatly extended. Young educated men taking to these new occupations should show a greater spirit of adventure and as land is all taken up in convenient places, they should go into the interior. There are no parts of the State more rich in agricultural prospects than the malnad, yet the process of deterioration is rapid. There are many industries subsidiary to agriculture and if our intelligent young men take up agriculture with a determination to make it yield good profits, I feel sure they will not only add greatly to the wealth of the country but increase the avenues of employment. Instead of bemoaning their fate that after an expensive education they cannot obtain suitable employment, they should become producers and create more sources of employment. Large areas of land now reserved as Amritmahal Kavals will become available. I have no doubt Government will afford special facilities to intelligent young men belonging to the educated classes to take up agriculture.

7. Our tanks are rapidly silting up and the construction of new tanks does not keep pace with the reduction of irrigated land due to such silting. There is unnecessary waste of water and our people are unaccustomed to the discipline that might enable them to make the best use of the water though it might involve sacrifice of individual interests in particular years. Crops likely to require less water, especially garden, should be encouraged. The use of underground supplies of water is greatly neglected. This is a direction in which there is a vast field for great improvement. Government have very recently placed an officer on special duty to promote the use of electric pumps and give large concessions. The response from the people, I am sorry to say, is not commensurate with the liberal policies announced by Government in these matters from time to time.

8. Water for irrigation will be provided from the Irwin Canal this year. There are serious problems there such as rendering fit for irrigation large areas of land, supply of seed, manure and improved agricultural implements, resettlement of the population which have to be solved jointly by the agriculturists and the Government. Our educated young men should try and obtain a footing and take part in the new development.

9. Greater attention should be bestowed on agricultural education for the idea that by merely imparting general education, any marked benefits will be derived by means of agriculture does not seem to be correct. We have several plans—one to combine agricultural education with general education and the other to separate the former after a slight foundation. It is difficult to say which of the two systems can be made to conform to our requirements but it cannot be denied that want of a resolute policy to evolve some suitable system and adhere to it has greatly impeded the progress of agricultural education. To face the increasing competition of the future, to carry on production with profit when there is an increase in the general standard of living, to meet the tariff and other barriers each country will erect so as to give its people the maximum benefit from its productive capacity, will require a newer type of agriculturist well ground in his own profession with broad outlook and capacity to make the most of his own personal efforts and combine for purposes of common benefit and unless we did our best to cope with these problems, our economic condition will become more and more miserable.

10. The agricultural population is the backbone of the country. The prosperity of the State depends upon them. We are all therefore greatly interested in your well-being. Nothing excites our admiration so much as the fact that in the most adverse conditions you do not lose your hope nor relax your efforts and I wish that the spirit of self-sacrifice and work that characterizes you will enable you to earn more and more rewards as a result of the advancement of education and your material well-being.

I wish your Conference every success.

# Report on Cinchona Cultivation in Java.

BY

**Leslie C. Coleman, C.I.E., M.A., Ph.D.,**
*Director of Agriculture in Mysore.*

The cultivation of Cinchona in the Dutch East Indies furnishes one of the most striking examples of the value of science as applied to agriculture. Starting, as far as initial material is concerned, on a level with British India, the Dutch have, through the application of science, forged ahead till they now produce approximately 90 per cent of the quinine of the world.

The cultivation of Cinchona was started by the Dutch East Indian Government in 1854 when the first seeds and plants were imported and set out on an area on the mountain plateau of Pengalengan (the Preanger highlands) south of Bandoeng. This site was chosen on account of the elevation (about 5,000 feet) and the nature of the soil which is a rich and friable loam well supplied with humus.

In 1872 a new species, Cinchona Ledgeriana, whose bark has a much higher quinine content than the other Cinchona species previously grown, was introduced and from this time began the planting of Cinchona by private enterprise. Almost from the first the Dutch East Indies Government has aided in the development of the industry from a planting side more especially through the selection of higher yielding types and through its work on the grafting of the more delicate Cinchona Ledgeriana on to more vigorous stocks such as C. succirubra. Private enterprise now furnishes about 90 per cent of the quinine bark produced in Java, only about 10 per cent being produced in the Government Cinchona Plantation at Tjinjiroean.

My investigations had to be confined to the agricultural side of Cinchona and quinine production. Even had I been qualified to investigate the manufacturing side it would have been impossible for me to do so, for I was informed that strangers were, without exception, refused entrance to the quinine factory in Bandoeng, the only one in Java.

The very short time at my disposal compelled me to restrict my study to a visit to the Government Cinchona Plantation at

FIG. 1.—Map of Java. Places visited are underlined.

Tjinjiroean (see Map Fig. 1) to which is attached the Cinchona Experiment Station. My main objects were to obtain seed of one of their best selections of Cinchona Ledgeriana and to ascertain whether it would be possible to obtain Cinchona bark from Java for the manufacture of quinine in Mysore pending the establishment of plantations for the production of our own bark. I naturally learned in addition as much as I could of the methods followed on both plantation and experiment station as time and circumstances would permit.

Unfortunately the Director of the Station and Plantation, Dr. Kerbosch, was absent on a trip to America and the plant breeder, Dr. Spruit, was also not present on the station at the time I visited it. I had, therefore, to gain what information I could from the Acting Director of the Plantation, Mr. M. A. van Roggen, whose kindness and courtesy remain a very pleasant memory.

The plantation is one of the oldest in the world and comprises a planted area of approximately 900 hectares (2,225 acres). It has been in existence for the past 80 years. The plantation is run as a commercial concern by Government while the Experiment Station is controlled by the Allgemeen Landbouw Syndicate with which the Government is associated. The plantation management is a part of the Vereeniging van Kinabastproduenten (Union of Cinchona Bark Producers) an organization which embraces all the Cinchona plantations in Java. This organization of Cinchona planters is closely associated with the quinine manufacturers in Java and Holland, the whole forming the so-called Kina Bureau. The Kina Bureau fixes the production of bark and quinine every year. It also apportions the amount of bark each estate will produce and the amount of quinine and other products each factory will manufacture. It also fixes the price of bark, quinine and other Cinchona products. The Government plantation produces about 10 per cent of the Cinchona bark produced in Java and, I was informed, is at present working at just half capacity.

As already stated, the Plantation and Experiment Station are situated in the Preanger highlands at an elevation of approximately 5,000 feet. The rainfall in this district averages about 150 inches per annum and is very well distributed. The soil is a very fertile and friable loam, volcanic in origin. It is decidedly retentive of moisture

as evidenced by the fact that, though the district had passed through an exceptionally dry period, the soil was still quite moist within six inches of the surface. The surrounding area is given up entirely to the cultivation of Cinchona on the higher elevations with tea lower down at between 4,000 and 5,000 feet. The Preanger tea district is the finest in Java and one of the finest in the world.

The plantation consists almost entirely of Cinchona Ledgeriana for the most part grafted on to C. succirubra stock. There are about 70 hectares (about 170 acres) of C. succirubra. Where possible C. Ledgeriana is grown from seed but this is only feasible on soils which have not previously carried a Cinchona crop. As most of the area has had Cinchona on it two or three times Ledgeriana will not grow well and has therefore to be gratted on to the much more vigorous succirubra stock. This enables the growers to use material from their best selections of Ledgeriana. Nevertheless the use of Ledgeriana seedlings is more profitable wherever they will grow well as the trees are harvested roots and all and the roots contain from $\frac{1}{4}$ to $\frac{1}{3}$ of the quinine in the whole tree. As succirubra yields only about 2 per cent of quinine while the best selections of Ledgeriana yield nearly 9 per cent, the desirability of growing Ledgeriana on its own root system is obvious.

The main plantations of Ledgeriana are planted out about a metre each way and are then thinned to two metres (about $6\frac{1}{2}$ feet) each way at the end of 4 or 5 years. The plantations reach their highest economic productivity at from 20 to 25 years. After this the increases in yield per tree are not proportional to the age. They are, therefore, harvested entire at this age, the roots being dug out. After harvest the land is planted with Acacia decurrens which is left for 5 years when it is removed and a fresh Cinchona plantation started. Fig. 2 shows part of a field of C. Ledgeriana on a slope about ready for harvest.

After removal and partial drying the bark is beaten off with wooden mallets, even the fine roots being subjected to this treatment (see Fig. 3). It is dried in the sun on special platforms which have a movable roof which can be dropped over them during a rain (see Fig. 4). From here it goes to a Sirocco drier. It is then ground into fairly fine powder and sacked in rectangular sacks or bales

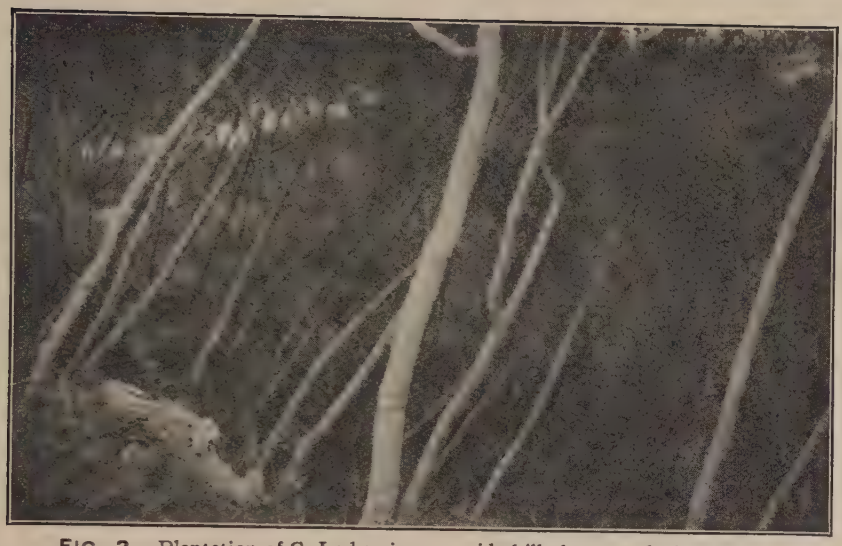

FIG. 2.—Plantation of C. Ledgeriana on side hill about ready for harvest.

FIG. 3.—Women removing bark from harvested billets of Cinchona Ledgeriana. Ledgeriana plantation in background about ready for harvest.

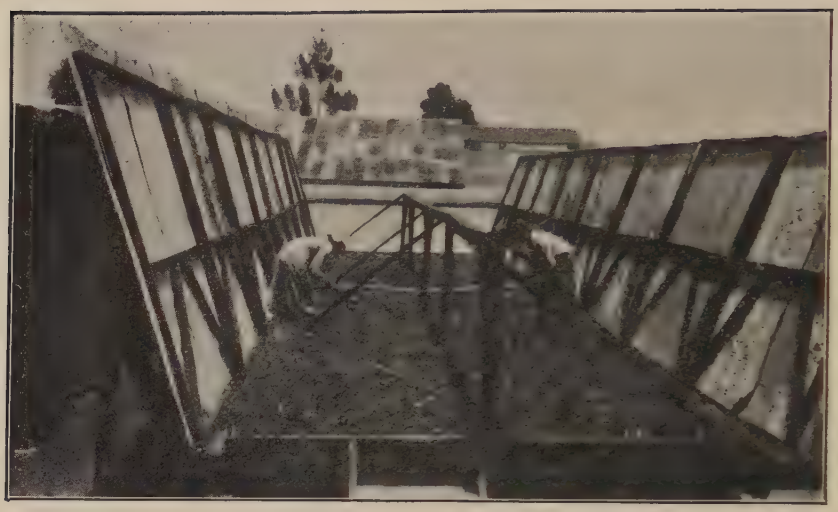

FIG. 4.—Drying platforms for cinchona bark—covers of galvanized iron can be placed over the platforms in case of rain.

FIG. 5.—Row of old C. succirubra trees in front of C. Ledgeriana plantations.

about 4 feet by 1 foot by 1 foot. The bark powder is shaken down and the bale is shaped with a wooden mallet and then sewed up. The best packing is done for bark which has to be sent to Holland, the short journey to the Bandoeng factory calling for much less care in this regard. The plantings of succirubra which are dealt with in much the same way both as to treatment in the field and in harvesting, yield a bark which is all sent to Holland for the production of other medicinal products, such as quinine wine. The succirubra bark is packed and shipped in tea chests. Fig. 5 shows a row of succirubra trees in front of a Ledgeriana plantation.

Returning to the starting of the plantation, the seed is carefully collected and sorted. The sorting is done in a dark room on boxes containing an electric light and with a cover of ground glass. The seeds are spread out on the illuminated ground glass and the plump healthy seeds are selected out with a feather. A special gang of trained women are used for this purpose. This seed is tested for germinating capacity in special germination dishes on filter paper which is kept at approximately constant moisture. If there has not been a germination of 90 per cent within 19 days the seed is discarded. Seed, if properly dried and kept, will remain viable for three years. I saw some germinating satisfactorily which had been kept two years.

The seed beds for germination on a large scale are prepared with fresh soil each time. They use jungle soil collected from special tracts but Mr. van Roggen does not believe there is any special virtue in this. The soil is not sterilized before using. The seed beds are specially shaded with mats which can be raised and lowered (see Fig. 6). They have been experimenting with different devices for shading and I saw one such which was much more elaborate. Mr. van Roggen expressed the view that they had not yet found anything better than the simple form illustrated.

The nurseries which I saw (Fig. 7) were of succirubra stock on to which Ledgeriana had been grafted. The succirubra seedlings are planted out the previous year. Ledgeriana material for grafting is taken from branches or branch portions of over a year's growth which have just hardened or lost their green colour. The grafting is usually done in the nursery beds, but some basket plants had been specially prepared to show me the method followed. This

is illustrated in Fig. 8. It is a rather crude method of side grafting. Branches of about two nodes and just over a year's growth after being properly tapered to a wedge shape are inserted into a slit made in the side of the stock. The whole is tied with plantain fibre and then covered with grafting wax. The leaves of the succirubra stock are left until the appearance of the first leaves on the scion when the stock is topped. The whole stock is cut back to the point of insertion of the scion only after a good growth of the latter has started. Mr. van Roggen informed me that a man with a woman helper could graft from 300 to 500 plants in a day. Each labourer is paid about 35 cents (between 5 and 6 annas) per day. The cost for grafting plants enough for an acre (3,000) is about 12 guilders (about 13 rupees). He said they obtained about 90 per cent of successes in grafting but in the nursery beds I examined there could not have been more than 70 per cent of successes.

The whole production is kept under chemical control. Small samples of the harvested bark are, when thoroughly dried, ground in a mortar and extracted with benzene 7 hours at 70° C., neutralized with HCl, and crystallized as quinine tartarate. The well-equipped chemical laboratory on the plantation makes analyses not only for the plantation itself but for all estates in the combine.

Dr. Spruit who is in charge of selection work at Tjinjiroean was unfortunately not on the station, so I had not the privilege of being shown over the experiment station plots by him. However, Mr. van Roggen was a very painstaking guide. The work that I saw was concerned exclusively with the testing out of selections of C. Ledgeriana. Although Dr. Spruit is also concerned with the investigation of insect pests and fungus diseases I saw practically nothing of this side of the work. I may say that the test plots and plantations in general had a very healthy appearance and I saw no evidence of any serious disease. There are a number of insect pests including the Atlas moth and an insect similar to or identical with the mosquito blight of tea. Of fungus diseases a bark canker is the most serious.

Turning to the breeding work, the C. Ledgeriana selections suitable for grafting on to succirubra stock are, after grafting, planted out in test plots containing from 2 to 4 rows at spaces of 1 metre to

FIG. 6.—Seed beds shaded with roofs of bamboo matting.

FIG. 7.—Nurseries of C. Ledgeriana on C. succirubra stock.

FIG. 8.—Grafting of C. Ledgeriana.
The man to left is the grafter. The woman to the right ties the grafts and covers them with wax from pot in front of her.

$1\frac{1}{4}$ metre apart. The selections are, in the first instance, made on the basis of vigour as it is not possible to tell before the age of 4 or 5 years what the quinine content is likely to be. It was an earlier thought that there might be correlations between certain morphological characters and quinine content. Thus it was supposed the large leaved selections would have low quinine content and *vice versa*. This was on the analogy of C. succirubra which is large leaved and has a low quinine content. Similarly there was thought to be a correlation between colour of leaf and quinine content, the red leafed varieties having the higher content. Both these suppositions have proved false and no correlation whatever seems to exist between size or colour of leaf and the quinine content of the bark.

In the testing gardens alternate rows and plants in the row are thinned after 4 or 5 years. In the preliminary test no attempt is made at an accurate comparison by means of control plots but in a second series of plots each new clone (selection for grafting) is alternated with a standard variety (W3) which has, up to the present, proved the best selection obtained. This second generation test is looked upon as quite necessary as differences in growth observable in the first generation plots may be due to inequalities of the soil. Figs. 9, 10, 11 and 12 give views in the selection plots.

The actual testing for quinine content is done at the age of 4 or 5 years. This is done on the basis of (*a*) percentage quinine in bark estimated in a strip of bark about 10 cms. wide around the stem at from 3 or 4 feet height, (*b*) the thickness of the bark, and (*c*) the circumference of the tree.

In taking up the question of supply of seed and bark with Mr. van Roggen I had naturally to be as tactful as possible. He expressed a view, quite natural for a Dutchman, that they had reached such an advanced stage in the production of quinine that there was not much use in any other country attempting to compete. As regards supply of seed or any living material he informed me that this could be done only with the approval of the executive committee of the Vereeniging van Kinabast Produzenten. He thought there was a chance of getting a small quantity of seed if a written requisition was sent up. I visited Tjinjiroean on the 30th September and 1st October. On the afternoon of the 1st October I sent Mr. van Roggen a requisition for seed. I received a reply just before I sailed stating he had

received permission to let me have some. I then got into touch with him over the phone and managed to get a small supply of two grammes of one of their best selection of C. Ledgeriana seed sent to the boat so that I was able to bring it along with me. This seed is certified to have a germinating capacity of 98 per cent. The sample contains from 5,000 to 6,000 seed, so that a fairly large scale experiment on C. Ledgeriana can be carried out. Experiments on the germination of this seed are, with the approval of the Chief Conservator of Forests, at present under way in the Botanical Laboratory of the Department where special facilities for seed germination exist.

To my surprise I found the question of bark supply a more difficult one. Mr. van Roggen informed me that bark supply is entirely under the control of the Kina Bureau and that I should have to write to the Secretary of the Indian Delegation of the Kina Bureau in Batavia to get information on the subject. I wrote at once to the Secretary, Mr. Stolz, to arrange an interview and received a reply stating that while he would be glad to see me he could give me no information, as the supply of bark was controlled entirely by Kina Bureau in Amsterdam.

On the morning of the 29th October I had an interview with Mr. Stolz and with the President of the Nederlands Handels Mattschappij, Batavia, on this question. They informed me that through an agreement between the Kina Bureau and Messrs. Howards of London the supply of bark from British-owned Cinchona estates in Java is controlled by the latter firm. They thought that possibly a supply might be arranged for through Howards but that they personally could do nothing in the matter.

In conclusion I must place on record my appreciation of the kindness and courtesy of Mr. van Roggen and of the representatives of the Kina Bureau. I believe if the experiments with the growth of Cinchona Ledgeriana prove at all successful it may be possible for me to get more seed for an extension of plantations.

I have, at the same time, brought back with me all the publications of the Cinchona Station that were available. Unfortunately these are all published in the Dutch language but if the cultivation of Cinchona is to be taken up seriously in Mysore it will, I believe, be quite essential to keep in touch with the work that is being done in Java.

FIG. 9.—View of test garden of C. Ledgeriana selections.

FIG. 10.—Rows of C. Ledgeriana selections in test garden.

FIG. 11.—View of second generation test garden.

FIG. 12.—View of test garden to show difference in growth of different selections. The lower plants to the right are of varieties with reddish leaves.

## SELECTIONS.

### Milk Fever or Dropping After Calving in Cows.

By L. S. Joseph, G.B.V.C.,

*Cattle Superintendent, Imperial Institute of Agricultural Research, Pusa.*

(This note may be of practical use to cattle-owners. No attempt has been made to summarise recent research on the subject.)

This nervous disorder which is unknown in common herds is pre-eminently one peculiar to high milk yielding individuals. It develops suddenly in plethoric cows after calving and is characterized by loss of consciousness, of muscular control, by hypertermia, convulsions and death from coma.

The disease attacks cows of high productive capacity, up to their eighth calf between the ages of 10 and 11. Although age has a marked influence, it is only subsidiary to the milking qualities. The disease seldom attacks a cow with the first or second calf when her system is as yet immature and the milk yield has not reached its maximum. Even in a judiciously managed dairy, the best cows are often carried away between these ages.

**Pre-disposing causes.*—Heavy and rich feeding prior to calving and immediately after, is a most prominent predisposing cause.

The drying up of the milk secretion before calving in a cow which is normally a heavy milker is another potent factor. Constitutional predisposition to this trouble is also to be reckoned with.

This disease made its first appearance in the Pusa herd in 1924 and carried away three of our best half-Ayrshire-Montgomery cows.

*Treatment.*—Medicinal treatment is not so effective as inflation of the udder with sterilized air. All the cases which came under my observation were treated by inflation of the bag with sterilized air, and recovery in each case was instantaneous. The technique is simple, soothing and most effective of all, and can easily be practised by any cattleman with ordinary experience and average intelligence.

Place the animal in a comfortable position, as far as possible, in an open yard with the head well raised. Apply cold applications to the head and spine, wet rags or ice bags. Strip the udder completely and

*Recent research tends to show that "milk fever" is due to depletion of mineral salts, particularly calcium, from the blood stream, and that cases can be cured by the administration of calcium salts without any other treatment.

Inflation of the udder, as described in this article, is however still the most ready and effective method of treatment for every-day practice.—Editor.

inflate each quarter with air by means of an injector, or in the absence of an injector, an excellent substitute can be made from an ordinary cycle pump and valve. The animal being in a recumbent position, it is practicable only to treat one-half of the udder first.

Hold the teat between the thumb and forefinger of your left hand and introduce the valve, which should be thoroughly sterilized and well lubricated with either boro-vaseline or any other antiseptic lubricant. Place some sterilized cotton wool or lint very lightly on the free end of the valve before fixing the delivery tube of the pump and tell your assistant to pump air evenly and steadily. I believe in inflating the bag to its utmost capacity and kneading the bag from the base of the teat upwards, though some practitioners recommend only partial inflation. By complete inflation of the bag, the animal recovers quicker. She gets on her feet within half to three-quarters of an hour after the inflation of the bag with air. The economic value of this treatment is almost inestimable considering that this fell disease has been the bane of the best dairy herds.

The precaution against this disease is to all but starve animals which are predisposed to this disease a fortnight before and after calving. Keep them on bran mash and green food alone.—*The Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Vol. IV, Part II.

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## Prohibition of Import of Diseased Rubber and Coffee.

*Government of India Notification No.* 534—*Agri., Department of Education, Health and Lands, dated New Delhi, the* 1*st April* 1931.

In exercise of the powers conferred by the sub-section (1) of section 3 of the Destructive Insects and Pests Act, 1914 (II of 1914) and in supersession of the order published with the notification of the Government of India in the Department of Education, Health and Lands, No. 1343—Agriculture, dated the 21st June, 1930, the Governor-General in Council is pleased to direct that the following further amendments shall be made in the order published with the notification of the Government of India in the Department of Revenue and Agriculture, No. 580-240 dated the 22nd June, 1922, namely—

(1) Paragraph 8–A of the said order shall be omitted.

(2) For paragraphs 7 and 9 of the said order, the following paragraphs shall be substituted respectively, namely—

"7. Heavea rubber plants and Heavea rubber seeds shall not be imported into British India from America or from the West Indies except by the Director of Agriculture, Madras Presidency."

"9. Coffee plants, coffee seeds and coffee beans shall not be imported into British India except by the Director of Agriculture, Madras Presidency, who shall take all measures necessary to ensure that such coffee plants, beans or seeds as are imported by him are free from plant diseases and injurious insects. Provided that the prohibition hereinbefore contained shall not apply (*i*) to roasted and ground coffee, or (*ii*) to a consignment of unroasted or unground coffee beans or seeds produced in India and covered by a certificate of origin in the form set forth in the third schedule appended hereto and signed by one of the authorities specified in the fourth schedule appended hereto."

(3) After the Second Schedule to the said order the following schedules shall be inserted, namely—

THIRD SCHEDULE.

(*Paragraph* 9)

CERTIFICATE OF ORIGIN FOR INDIAN COFFEE BEANS OR SEEDS.

| Name of Consignor | Name of Consignee | Gross Weight | Number of Packages | Mark of Each Package | Name of District in which produced |
|---|---|---|---|---|---|
| | | | | | |

Certified that the above consignment of raw coffee beans or seeds is Indian produce grown in the district specified above.

No. of Railway Receipt or
No. of Bill of Lading.

*Signature of Certifying Authority.*

*Signature of Consignor.*

FOURTH SCHEDULE.

(*Paragraph* 9)

Certifying authority—

(*i*) The Deputy Director of Agriculture, Chickmagalur, Kadur District, Mysore State.

(*ii*) The Director of Agriculture and Fisheries, Travancore State.

(*iii*) The Superintendent of Agriculture and Punchayats, Cochin State.

(*iv*) The Director of Agriculture, Madras Presidency.

(*v*) Any other officer whom the Government of Madras may appoint in this behalf by notification in the *Fort St. George Gazette*.

(Sd.) F. NOYCE,

*Secretary to the Government of India*,

## Feeding and Care of the Dry Cow.

The intelligent feeding and care of the "dry cow" is an important factor in the economical production of milk. The amount and quality of milk which a cow will give depends to a great extent on the feed and care given during the dry period. Good condition reflects in the milkpail. A cow that freshens in a thin and run down condition is not in shape to drop a strong healthy calf, nor to do justice to herself at the pail. Cows which are in good flesh at calving are capable of producing not only more milk but also more butter-fat during the succeeding lactation period than cows which are very thin. It is a well-established fact that the more fat the cow has on her body at calving time, the higher will be the percentage of butter-fat in the milk for some time after freshening. A pound of grain during the dry period is worth at least three pounds of grain fed after the cow has freshened.

*Length of Dry Period.*—The process of milk production, particularly in the case of a heavy producing cow, coupled with that of the production of off-spring, is a severe tax upon the vitality of the cow. In order that she may begin her period of lactation in good physical condition, it is desirable that she be given a rest previous to freshening. The rest period enables the cow to produce at a maximum by using her stored up energy for milk production. The proper length of the rest period seems to depend on her age, the quantity of milk which the cow has produced, and her condition as regards flesh. A young cow that has milked heavily and is not yet matured should have more rest than a mature cow. From 10 to 12 weeks is satisfactory for heifers if a heavy production is expected of them. Mature cows that have produced heavily should have at least six to eight weeks rest. Thin cows may need somewhat a longer period.

*Drying Off.*—It is sometimes difficult to get a heavy milking cow to dry off so as to give her the period of rest necessary to put her in good physical condition at calving time. The best way to dry her off is to take away all grain and succulent feed and give her hay or even straw, and water. Lessening gradually the frequency of milking, and not milking the cow completely dry, both help in drying her off. The cow should be milked once a day for the first few days and later on once every other day, and so on until the amount has been reduced to three or four pounds daily, when she need no longer be milked. It is important that the drying-off process should take place gradually in order to prevent injury to the udder.

*Feeding.*—The care and feeding of the dairy cow previous to freshening is one of the important factors in securing good milk production. If the dry period happens in the summer and pasture is good, she will not require any additional feed unless she is very thin, in which case she should receive four or five pounds of grain daily. If the dry period comes in the fall or winter, the cow should get extra feed. As soon as the cow is dried off no better ration can be provided than silage and alfalfa or clover hay with 2 to 4 pounds of concentrates for a cow in moderate flesh. A cow which is thin should get from 4 to 6 pounds of grain daily. A satisfactory grain mixture for this period when fed in conjuncton with alfalfa or clover hay and silage, consists of 200 pounds of ground barley and 100 pounds of ground oats or wheat bran. If she is not getting legume hay the protein of the grain should be raised and this can be done by increasing the amount of bran or by the addition of oil-cake meal. In this case adding either 100 pounds of bran or 50 pounds of oil-cake meal to the above ration is recommended. It is also desirable at this stage to supply minerals in the form of steamed bone meal, ground limestone or wood ashes. These may be mixed with the grain at the rate of 3 or 4 pounds to a hundred pounds of grain.

*Feeding of Calving.*—Special care is required in the feeding of the cow at freshening. Cows should be kept on a somewhat lighter ration just prior to calving and the feed should be of a laxative nature. The ration should be reduced at least a week before the cow is due to calve. Two or three days before calving the cow should have nothing but light bran mashes well salted. Immediately after the cow has calved it is a good practice to give her warm water to drink and follow this with a warm bran mash. For a few days after calving continue to feed her sparingly on laxative feeds. The feed can gradually be increased and at the end of two weeks the cow can be on full feed if she is carefully watched. The heavy milking cow should not be milked dry until after the third day as such procedure frequently induces milk fever. —*Dominion Experimental Farms, Ottawa, Ontario,* Seasonable Hints, No. 52.

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## Irrigation of Citrus Trees.

Irrigation is, perhaps, one of the most important horticultural operations in a colony like Cyprus, but if there is one practice which requires to be criticized generally and severely, it is the method used in the application of water.

Water cannot be said to be plentiful here, with the exception of

a few districts, notably Lapithos, and yet growers seem to go out of their way to over-water their trees and to leave the soil in a water-logged condition! Citrus trees especially cannot stand over-watering too long. They turn yellow, the foliage drops and they are almost certain to develop root-rot or "Collar rot" especially when a susceptible stock such as the "Sweet lemon" is used.

The most common system of irrigation in this country is a basin system of a particularly pernicious type. The proper basin system gives a good uniform distribution if the basins are properly made, and is recommended for light sandy soils. In the basin system employed in Cyprus the water is allowed to stand round the trunks of the trees or at least to come into contact with them.

In some groves, in order to prevent this, the earth has been thrown up round the trunk a foot or so high. This is also a bad practice, as the water penetrates the loose earth which remains moist for some considerable time and furnishes ideal conditions for "collar rot" infection. It would be better to have the water in direct contact with the trunk, as this would sink away in a comparatively short time. Neither of these practices are, however, to be recommended. They are both incorrect.

If either the "basin" system or a system of flooding is to be used, then a ring of earth should be thrown up in the form of a ridge round the trunk and about 2½ feet away from it, high enough to prevent water from flowing over it and wetting the trunk.

No system of tillage, irrigation or manuring is correct that does not provide for the treatment of the *whole* of the soil. The roots of the trees eventually penetrate into all the available space and there is no point in having a wide planting distance unless the soil in between the trees in the row and between the rows is kept well watered.

The furrow system of irrigation is probably less expensive than the basin system to install, but it can only be carried out when the trees are planted a proper distance apart. Cyprus plantings are, generally speaking, too close for furrow irrigation at present, but there is no reason why future plantings should not be irrigated by this method if other conditions are satisfactory, especially if cement pipes were installed. This latter modification, whilst admittedly expensive, is an ideal method of irrigation as it economizes water, and prevents seepage which is very harmful to the trees.

Where furrow irrigation is practised the "fall" should be between 1½ and 2 per cent and the "run" not greater than 300 to 400 feet. Otherwise proper penetration is not attained; the "fall" should also be

uniform for the entire distance of the "run", as, if it is not uniform, one particular portion is certain to be either over-irrigated or under-irrigated.

The question of frequency of irrigation is one which is fraught with much controversy, but there is little doubt that the tendency in Cyprus is to irrigate too frequently.

Very dry and warm areas require more water than those of greater humidity and lower temperatures: different soils require different irrigations even under the same conditions of climate. Heavy soils are more retentive of moisture than light soils and, therefore, require less frequent irrigations.

In the citrus-growing area of California, the "coastal" section was found to require an interval between irrigations of 34 to 41 days whilst the inland area required water every 18 to 21 days. The interval, of course, varies tremendously with soil types as indicated above and on the heavier types of soil in California an interval of 60 days was necessary whilst the *average* for the whole of the coastal area was only 41 days.

In general, in order to secure the best results, water should be applied when needed. The trees should not be allowed to show wilting before they are watered as this may cause a serious fruit drop.

Water is probably run for much shorter periods in Cyprus than in other citrus-producing countries where it is run from 24 to 48 hours or even longer and this should be taken into account in determining the frequency of irrigation. The object should be to get a thorough penetration to a depth of 3 to 4 feet. On heavy soils this will take a considerable time, but on light soils, a brief application only will be required. Growers should not trust their own judgment, but test the soil for themselves by digging to the required depth or by testing with a soil auger.

Whatever system of irrigation is employed, water should be placed in between the trees in the row, in between rows and well under the trees, but *not* against the trunk.

In conclusion, not only all growers of citrus fruits, to whom these remarks are principally addressed, but also all gardeners and farmers are earnestly requested to make a close study of this question of irrigation by making tests for themselves. No hard and fast rules can be made. They can be certain that diligent efforts will be repaid by increased crops and a general improvement in the health and well-being of their plantings.—*Agricultural Supplement to Cyprus Gazette*, No. 2155.

## Soil Management.

Particularly with Reference to Coffee Cultivation.

By W. S. Martin, m.sc., ph.d., a.r.c.s., d.i.c., a.i.c.,
*Agricultural Chemist, Uganda Protectorate.*

A soil rich in plant food is not sufficient in itself to supply the essential factors for plant life.

In an analysis of any crop, moisture is always first determined and is always present to a greater or less degree, but the amount of water used by the crop is not measured entirely by the amount contained in the plant at any given time. Investigations in the field and in culture solutions have shown that the root hairs of the plant are constantly absorbing water which ascends through the roots, stems and branches to the leaves from which it is evaporated into the air. The amount of water which passes through a crop in this manner is enormous, amounting to roughly 500 lbs. for every pound of dry matter produced. This water acts as a vehicle for mineral plant foods, controls the temperature of the plant and is all-important in plant processes. In a climate like this, where bursts of rain are followed by more or less long dry periods, it is particularly important to conserve the water supply. Unfortunately, the elements are still beyond our control and farming continues to be a huge gamble, we are told: but it is interesting to realize that we can always increase the odds in our favour by the skilful soil management.

Another important factor is air. A water-logged soil is just as unhealthy for most plants as an extremely dry one, because it sets up rotting in the roots and eventually kills the plant. Thus, the ideal soil is one which is highly retentive of water and yet never water-logged.

Such a soil must have a high percentage of pore space, that is a granular soil. A powdery soil has a low pore space and is very much subject to wash and erosion. These two factors, water and air, are just as important as plant food, which will be considered last, because it rarely consists of more than five per cent of the crop. The main food factors are nitrogen, phosphorus and potash. There are comparatively few soils which do not contain sufficient of these materials for the crop, although there are many soils on which dressings of either or all of these materials give an increased yield. The reason is, that in many soils, these materials are not available, meaning that they are not in a fit state to be absorbed by the plant roots. Good soil management supplies the remedy of these cases, as will be seen later.

This leads to the subject of the economics of manuring. One can only decide whether a manure will pay by carrying out field experiments.

Try the manure on a few lines and leave others as controls and take yields and costings as accurately as possible. Such experiments must be carried out for the particular estate because the response of different soil types to manure varies.

Although it is essential to have plenty of mineral plant food latent in the soil particle, a relatively small quantity available at a given time is sufficient for the plant's needs, something of the order of fifty to one hundred parts per million of the soil solution. It is the aim of good soil management to render available the plant food material already present in the soil before thinking of artificial fertilizers.

The majority of the plantations in Uganda have been opened up on elephant grass land. Such land has usually a deep soil of good structure. The first few crops taken off this soil are invariably good, but fall off gradually. An examination of soil from such an area may show that it is a mixture of good crumbs of varying sizes, or it may be fine and dusty. The latter state is chiefly the result of clean weeding, necessitating frequent hoeings which continually add to the quantity of pulverized material. The fine dusty soil has a minimum of pore space and water-holding capacity. In a wet season it easily becomes water-logged, inhibiting the growth of the tree owing to lack of air; while early in a dry season it has dried out and caked, making the crop suffer through lack of water. A comparison of the soil on an old coffee plantation with the virgin soil of elephant grass land ten yards away revealed the fact that top soil in the first instance was very fine and dusty, four inches in depth, with no crumbs, while the virgin soil adjacent was good black soil fifteen inches deep, and well granulated.

In a comparatively short time a good soil in excellent tilth had been ruined by bad management. Clean weeding and cultivation had allowed the sun to burn out all the humus, which acts as a cement for the particles in the granule; rains had carried a lot of the soil away, and the wind was doing its best with what was left. The crop was round about 2 cwts. per acre, but this is not surprising in view of the above remarks on the water and air requirements of the plant root.

How can a good soil structure be maintained? It is seen that hoeing and clean weeding reduce the good structure to dust, brings humus to the surface to be burnt out, until finally all the humus is removed, granules are non-existent, pore space is at its minimum, heavy rain tends to wash much of this soil away, and sun following rain bakes the remainder resulting in something harder than a road.

The remedy, the secret of soil management, may be expressed in one word—Humus.

Humus puffs out or lightens a heavy clay soil owing to the carbon dioxide produced by the micro-organisms living in it, much in the same way as yeast lightens dough. Humus is also invaluable as a cement for giving a good crumbly tilth on light sandy soils. It also has a very high water-retaining capacity which proves its value in drought periods.

Organic matter is the only possible food for the micro-organisms in the soil, it is oxidized under the influence of these organisms which derive their energy from the process. Oxygen is taken up and carbon dioxide given off. This carbon dioxide dissolves in water giving a weakly acid solution which slowly dissolves plant food from the soil particles. In this way it is obvious that a soil with a large quantity of organic matter has a big population of micro-organisms, more carbon dioxide formed, a stronger carbonic acid solution and so a better chance of obtaining the mineral plant food, phosphate and potash, from the particle.

The supply of nitrogen is more directly dependent on humus than on the mineral foods of the particle. The organic matter in the soil consists of plant residues containing nitrogen which is released and made available for the plant as nitrate, as a direct result of the activities of certain groups of organisms.

Other organisms deriving the necessary energy from the decomposition of humus are able to fix atmospheric nitrogen giving ammonia which is converted to nitrate by other organisms. Soils rich in organic matter may contain up to 1 per cent nitrogen while in dead unfertile soils it rarely exceeds .05 per cent or 1/20 of the previous figure. On all counts, humus is essential for a soil to be fertile and it is mainly the loss of humus which has caused the gradual decrease in crop.

There is a close relation between the incidence of sucking pests and soil conditions. A healthy tree is much less likely to be attacked than a less healthy one. An instance of this is the "root mealy bug" which has been observed to do greater damage during periods of drought on soils with a poor water content, and in exceptionally wet weather on water-logged soils. In the first instance the direct cause was water-starvation and in the second air-starvation. The very best means of prevention is the application of humus, which increases the water retaining capacity and at the same time improves the structure and facilitates drainage.

The conclusion is that humus in the soil is most necessary; but how can it be obtained and applied?

The first and standard method is green manuring, that is, the growing and digging in of a green crop. Leguminous crops are usually chosen, because they have the additional advantage of a bacterial organism, living in symbiosis with the roots, which fixes nitrogen from the air. Thus, legumes contain more nitrogen than any other crop, but it does not become available for further crops until it has been ploughed in and acted on by other organisms. There is an erroneous impression that the nitrogen fixed by legume organisms is made available for other crops during the growth of the legume.

The author instances elephant grass as an excellent mulch for coffee, but points out the danger of fire from such a mulch. Cattle manure and rotted cotton seed are also mentioned as proving useful for supplying humus.

In opening up new ground, it must be remembered that the burning of organic matter in clearing means a complete loss of valuable material and should be avoided as far as possible.* It is important to keep the soil covered from the very beginning, because more damage is done when the coffee is young and the soil completely exposed.

Shade trees may or may not be necessary for coffee. In any case, shade is essential to conserve the all-important humus.

The policy of doing nothing with the soil because it is so good that it needs nothing putting back, cannot be maintained. It is much easier and a better proposition to keep a soil in good heart than to put life into a dead soil. The policy should, therefore, be to start right by putting something into the soil each year as the crop takes its toll.

Remember that many weeds appear to be able to thrive where the main crop shows signs of failing. When these weeds are dug in and acted on by micro-organisms, the food which they have wrung from a reluctant medium becomes available for the main crop.

Lime is well known for its action in flocculating or forming granules in stiff clay and in changing the reaction of sour soils. Both these properties are valuable in improving the condition of life of the micro-organisms. Where active steps are being taken to conserve and increase the humus content of the soil it would be wise to experiment in the use of lime.—*The Malayan Agricultural Journal*, Vol. XVIII, No. 4.

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*The Author is here dealing with elephant grass land. In Malaya, when virgin jungle land is being opened, this destruction of organic matter seems to be inevitable. The best method of preventing loss of organic matter in such cases is to establish a cover crop as soon after the burn as possible before the humus and surface soil have been materially changed by the action of rain and sun.—Editor, *M. A. J.*

## Mineral Salts and Animal Nutrition.

By Lt.-Colonel H. A. Reid, O.B.E., F.R.C.V.S., D.V.H., F.R.S.E.

The influence of mineral salts upon health and nutrition has for long been surmised, but only of late has this aspect of dietetics received adequate recognition. In the past attention has been focussed more upon the energy-yielding properties of food as represented by its starch values and protein ratios. A well-balanced ratio was considered to be one in which the proteins, fats, and carbohydrates were present in definite proportions as determined by chemical analysis. More recently the study of group of affections characterized by their liability to occur among certain communities living under parallel conditions, disclosed a deficiency in their diet of substances of vital importance to the maintenance of health. Further observations and experimental evidence led to the deduction that, in order to be wholesome, food must contain certain beneficial elements which, originally described as accessory food factors, are now better known under the familiar term of vitamins. The conclusion was reached that food deprived of these elements is inadequate to the requirements of the body economy, and that in time more or less serious derangement of health will occur. It was also shown that in the process of preparation of food for human consumption these essential elements are frequently lost or destroyed—an observation which suggested a means by which the consequential effects could be controlled.

Owing to the more natural conditions under which animals are maintained, and the fact that, as a rule, their food is neither subjected to manufacturing processes nor devitalized by cooking, ill health in the animal kingdom dependent upon avitaminosis is, relatively speaking, of insignificant importance.

On the other hand, an absence or deficiency of mineral salts from their diet not only exercises a depressing effect, rendering them more liable to contact disease, but may also lead to functional disabilities of a serious economic nature.

There is evidence to support the view that failure to thrive and uncertainty in breeding amounting to partial or complete sterility, are frequently associated with mineral deficiencies.

Tuberculosis, mastitis, and septic conditions of the feet are also observed to be more frequent among milking cows undergoing an abnormal exhaustion of their mineral reserves through heavy lactation and an inadequate calcium intake.

The addition to the diet of common salt in the form of salt licks and its use as a pasture manure has from remote times been advocated

as a means of improving condition, increasing milk secretion and combating parasitic worm infestation among livestock. In hot climates, where loss from perspiration is excessive, common salt forms an important auxiliary in the systematic dieting of animals.

In general, the mineral deficiencies, which chiefly influence the health of grazing animals, are those associated with a lack of lime and phosphorus in an assimilable form. Arising from the profound disorders occurring among cattle and sheep in the event of calcium and phosphorus deficiencies, the study of diseases dependent upon mineral deficiencies originated.

On poor soils naturally deficient in lime, these disorders may be expected to occur, but they have been observed even on limestone formations under conditions when the lime is not available to the plant such as during periods of drought when the rainfall is insufficient to dissolve the mineral content of the soil. The effect of phosphorus deficiency is more evident during prolonged dry periods.

The earliest symptom of mineral deficiency due to lack of lime and phosphorus are a decline in the normal vigour of the livestock depastured in the deficient area. This is followed by a loss of condition or unthriftiness denoted in sheep by a ragged, lustreless appearance of the wool.

In the cattle similar symptoms are usually more prevalent among milking cows and generally occur three or four months after calving. Cattle under these circumstances develop a depraved appetite. In an endeavour to compensate for these deficiencies they will devour any substance which instinctively they know to be more or less rich in lime and phosphorus. The earth and bark eating habits of cattle may be traced to this source, and they will if possible find and devour the bones and rotting carcasses of dead animals. In this way, in Australia and possibly elsewhere, they not infrequently become infected with an organism present in putrid tissues—the Bacillus para-botulinus—and die of an acute paralytic affection.

Both species are peculiarly liable to suffer from spontaneous fractures of the bones and, on movement, a characteristic creaking sound is often heard due to erosion of the cartilage of the joints. Nodular enlargements of the ribs denoting the seat of former fractures, may generally be discovered on manipulation. Diarrhoea and the discharge of dark-coloured urine often accompany these symptoms. On post-mortem examination the bones are found to be light and porous looking, due to resorption of the lime salts, and the marrow of the long bones has a yellow, gelatinous appearance.

Definite evidence that these abnormal symptoms proceed from mineral deficiencies can be obtained on submitting the soil to chemical analysis, and the result will suggest the class of fertilizer suitable for use in the deficient locality. When it is not possible to remove livestock to fresh pasturage, they should receive a mineral mixture supplied in the form of compressed pellets or licks, or administered individually. Under such circumstances the administration of cod-liver oil to cattle is often attended by remarkably beneficial results.

Although not infrequent among grazing stock in certain areas, calcium and phosphorus deficiencies are still more prevalent among high-yielding cows maintained under modern, intensive conditions. A gallon of cow's milk is estimated to contain $\frac{1}{4}$ ounce of lime and $\frac{1}{3}$ ounce of phosphoric acid, therefore the average milking cow should be able to obtain a daily supply of at least three ounces of lime.

Pasture of good quality will provide the demands of the grazing cow for calcium, and irradiation by the ultra-violet rays present in sunlight, and iodine which is found in some foods and drinking water, also favour the retention of calcium and phosphorus.

In the case of the cow which is habitually stabled, nearly all these beneficial factors are wanting. Moreover, the modern practice of feeding a high proportion of digestible nutrient which stimulate milk secretion increases the output of lime in the milk. Vegetable concentrates as a rule are rich in phosphorus which, by combining disproportionately with lime, assists to deprive the body of the latter element. It has been estimated that a 2 cwt. grain mixture composed of oats, bran and maize yields 50 ounces of phosphoric acid, but only 3 ounces of lime.

To balance this unnatural loss the cow has to draw upon the mineral reserves of the bony framework, and a process of resorption of lime from the bones takes place.

There is little doubt that this continued mineral impoverishment, undermines the animal's health, predisposing it to infection with tuberculosis and other diseases. There is also evidence that under conditions of calcium deficiency abortion more frequently occurs.

The complaint known as Milk Fever which generally selects for its attack the heaviest milkers in the herd has been proved to depend upon a lowered calcium concentrate in the blood. It can be cured by intravenous and subcutaneous inoculation of calcium salts in the form of calcium gluconate.

Milk Fever is attended by symptoms of tetany which indicates that the decalcification of the blood affects also the endocrine gland system, particularly the thyroid and parathyroid glands, part of whose function

appears to be the control of calcium metabolism. Artificial tetany can be produced by the removal of these bodies.

In India malnutrition is frequently due to food poor in quality and insufficient in quantity but, in addition, the general poverty of the soil in lime, and more particularly in phosphorus, is prejudicial to the development and productivity of cattle in that country.

Orr considers that the possible cause of phosphate depletion of Indian soil may be due to the export of bones which has been going on for years without any serious attempt to make good the loss. It should be realized in this connection that all products of the land represent a loss which must be balanced by processes of cultivation and manuring. Starved soil is unprofitable and may, in time, prove disastrous.

According to McCarrison, there is in region of the Himalayas, and more or less throughout India, a shortage of iodine. In these localities the population are prone to develop goitre. It is certain that livestock in iodine deficient areas, though they may not suffer perceptibly from thyroid enlargement, are subject to the disabilities consequent upon a sub-iodised condition. These include malnutrition, deformities, and hairlessness dependent upon an unstable calcium and phosphorus balance, and increased susceptibility to infective processes due to thyroid insufficiency.

The interesting observations recorded by Kelly upon the effects following the additions of small quantities of potassium iodide to the diet of young, growing pigs demonstrate that iodine exercises a marked influence upon mineral metabolism, and leads to an increased assimilation and retention of nitrogen and phosphorus, and, to a lesser degree, an increased retention of calcium.

It has also been shown that iodine has a distinctly beneficial effect in cases of partial or complete sterility, and that its administration to lactating animals is followed by an increase in the milk secretion. In one recorded instance the administration of iodised salt to cows increased the milk yield by about 8 per cent over a year. This was accompanied by an increase in the fat content and percentage of solid matter. Its effect upon disease resistance through activating the thyroid gland has also been remarked on numerous occasions.

Iodine is present in the thyroid in the form of Thyroxin which contains 66 per cent of iodine. A normally active Thyroid constitutes one of the main bodily defences against infective processes. All plants absorb iodine in direct proportion to the amount available in the media in which they are grown, and the amount of available iodine in the soil

is the factor of greatest importance in determining the iodine content of plants. Where a deficiency occurs, goitre, malformation and other abnormalities defined by the term cretinism are liable to appear.

In acute infective conditions such as navel-ill of foals, influenza, and hæmorrhagic septicæmia, iodine has been successfully used as a preventive and cure. Walker and Taylor's experiments in India indicate that it may prove of very great value in the prevention and treatment of foot-and-mouth diseases.

The results of numerous observations and practical experience suggest that iodine may with advantage be incorporated in mineral mixtures intended to correct mineral deficiencies in the dietary of livestock.

Major Wall of Pietermaritzburh, a farmer of considerable experience, and of high repute on account of his successes at the various livestock shows held within the Union, habitually uses a mineral mixture prepared according to the following formula :—

| | |
|---|---|
| Bone-meal or bone flour .. .. .. .. | 40 lb. |
| Finely ground limestone (Agricultural lime) .. .. | 40 „ |
| Common salt .. .. .. .. | 20 „ |
| Flowers of sulphur .. .. .. .. | 5 „ |
| Sulphate of iron 5 lb. or oxide of iron .. .. | 1½ „ |
| Iodide of potash .. .. .. .. | 3 oz. |

*Directions.*—Dissolve the iodide in water and add salt as above. Mix all ingredients thoroughly. The above mixture should be mixed with concentrated food at the rate of 3 lb. of the mixture to 100 lb. concentrated food. Alternatively, one tablespoonful to mature cattle and horses mixed in the food daily, half quantity to young cattle, horses and sheep.

Manuring with stable manure or chemical fertilizers tends to exhaust the iodine content of the soil, therefore the addition of iodine to mineral mixtures will help to correct this tendency, because a certain proportion of the unabsorbed iodine will be excreted by the animals receiving it and be returned to the soil. On account of its iodine contents the use of Chilian nitrate of soda as a nitrogenous manure would constitute sound practice, especially on lands suspected to be deficient in this element.

The iron hunger complaint experienced in certain localities of Northern England, East Africa and New Zealand is an interesting example of the consequences which follow when livestock cannot obtain supplies of this mineral, sufficient to meet the needs of the body economy.

In New Zealand where this malady was first studied, it occurs among cattle and sheep on land generally of volcanic origin. Iron is present

in the soil in the form of an insoluble silicate unavailable for plant life, although grasses and legumes will flourish on the soil in question.

In a few months to a year after being depastured, ruminating animals begin to decline in condition and finally die from the effect of exhaustion following a progressive anæmia. In spite of a plentiful supply of apparently good grazing, the animals starve to death on account of the lack of iron. In the earlier stages this complaint may be readily cured by the administration of soluble iron salts.

Provided also the condition is not too advanced, affected stock will recover their health on removal to a different locality. Iodine, it is interesting to note, has likewise been found of value in this complaint.

Horses do not suffer to the same extent as cattle and sheep from the effects of mineral starvation. Their slower rate of development probably accounts for their lessened requirements in this respect when compared with the demands of the rapidly growing ruminants. Horses will thrive on iron deficient lands certainly fatal to sheep. They are not, however, exempt from mineral deficiency complaints. The disease known as "Osteoporosis", or "big head" on account of the enlargement of the bones of the face, is not infrequent among horses in certain parts of the world. It is nearly always associated with a lime and phosphorus deficiency although some investigators are of opinion that it cannot wholly be attributed to this cause.

In Ceylon, where Osteoporosis is prevalent, it can be controlled by the administration of calcium salts. The disease is frequently observed to occur on the phosphate deficient soils of India.

The disease known in India as Kumri, which manifests itself by the development of paralytic symptoms, attacks horses and is especially frequent in the phosphorus deficient areas of Bihar and Bengal.

The solution of many pathological problems may be found in their relations to mineral deficiencies. The resistance offered by the body tissues is the determining factor in bacterial invasion, and the realization that this resistance is largely dependent upon mineral assimilation constitutes an important step in preventive medicine. On the basis of this conception we may arrive at the fundamental cause of many of the difficulties encountered by livestock owners throughout the world today.—*The Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Vol. IV, Part II.

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## The Biology of Seeds.

By Sir J. Arthur Thomson, M.A., LL.D.,
*Emeritus Professor of Natural History in the University of Aberdeen.*

It is a sight to see a great heap of wheat in a granary, or a living cataract pouring down a chute into the hold of a grain vessel. A living cataract! That is part of the thrill, for each of these grains of wheat is a living embryo, as well as a condensed store of chemical energy which man and beast can quickly turn into work and warmth. As we let the grains trickle through our fingers, it is interesting to think of our prehistoric ancestors who probably noticed the big kernels of the Wild Wheat growing on the shoulders of Mount Hermon, and set them apart from cultivation. This was doubtless the beginning of that long patience which led to such first-class wheats as Marquis—surely one of the factors that won the War.

It is still more thrilling to think back and back to the ages when there were no seeds whatever, for it seems certain, judging from the fossils, that there were no seeding plants before the time of the later Devonian or Old Red Sandstone. There were many plants before that, but they were not seed-bearers. How they multiplied without seeds is a difficult question, to which we shall return at the end of this article. It is at present enough to notice that none of the flowerless plants such as ferns and horsetails, mosses and liverworts, have any seeds in the true sense. These are confined to Flowering Plants.

*The True Inwardness of Seeds.*—Botany books often tell us that seeds are "the ripe ovules"—the outcome of the full growth of the small, whitish bodies that we find inside the seed-box (badly called the ovary) of a flower. This definition is true enough, but does it not rather conceal the open secret that the seed is, or contains, an embryo, just as a fertilized egg does when the hen has brooded on it for a while? When we open a pea-pod and examine one of the seeds, we soon discover that it consists of two plump seed-leaves laden with stores of food, and that between these there is a tiny stem (plumule) and root (radicle), which will, by and by, sprout and grow. To understand how this embryo-plant came to be requires long study, but we must be content here to be very clear about the main fact that the embryo-plant developed, inside the "embryo-sac" of the ovule, from a fertilized egg-cell, just as if it were an embryo-animal. Thus a seed turns out to be a very young plant, usually well equipped with reserve food-material (on which we so largely depend), and usually surrounded by firm protective envelopes. As the

developing seed remains for some time in close union with the parent plant, from which it gets its food-materials both for growth and for storage, it may be compared without fancifulness to an embryo-mammal developing inside its mother's womb or uterus. In short, mammals and flowering-plants have achieved viviparity; that is to say, what is liberated from the parent is young creature, already more or less advanced in development.

*Fitness of Seeds.*—Every living creature that is at all complicated may be described as "a bundle of fitnesses," and although a seed is only beginning to live it shows many of these fitnesses or adaptations, some of them so intricate that long ages must have been needed for their gradual perfecting. Thus some seeds are particularly fitted for being scattered or sown. In most cases this is due to the fruits which may explode—like the pods of whins and broom; or may be borne away on the wings of the wind—like the nutlets of dandelion—and thistle-down; or may attract the hungry eyes of birds, with the result that the undigested seeds, are scattered far afield; or may adhere for a while to passing animals as butter-burrs to sheep or cleavers to rabbits. In many a case, however, it is the seed rather than the fruit that is adapted for being scattered. Thus the hairs that form parachutes may be attached not to the fruits, but to the seeds, as in the case of cotton; or the outer wall of the seed may be almost water-proof, so that long floating in the sea may be possible without injury; or the outside of the seed may become gluey when wetted, so that fixation in suitable moist soil is readily effected. In many other ways the seeds are fitted for being sown, and this is just one instance of their adaptations. We must also inquire into their fittedness for resisting injury, and their fittedness for sprouting when the time comes.

*Lying Low.*—We must confess that we have never got rid of a feeling of mild surprise when we look round a seedsman's shop and see the bags of dry seeds– all, or nearly all, alive. There is no need to be ashamed of this wonderment, for no biologist understands as yet the state of latent life into which many living creatures are able to sink without dying. Active living matter usually contains at least 75 per cent of water; but many seeds are dry and hard. Active living matter is in a colloidal state, *i.e.*, with innumerable particles or droplets suspended in a fluid medium, but there is not much hint of this in dormant seeds. It must be remembered, however, that a great part of a seed may consist of stored food that never has much life about it, and does not develop into living tissues as the embryo itself must do.

In some of the higher animals, such as the badger, the fertilized egg-cell develops for a time into an embryo, and then stops for a long rest. Among the lower animals also this resting is not uncommon, and in the plant world it is particularly characteristic of seeds. They develop up-to a certain point, and then they stop and do not begin again till they are getting ready for sprouting. It is natural enough that there should be a resting time after a period of development—life has many of these see-saws—but the quiescence may be thought of in other ways as well. Thus it might be very disadvantageous if the embryo-plant grew too big for the ovule or for the seed-box; and we must not too hurriedly say "Impossible". For, the embryo of the mangrove-tree develops so vigorously inside the fruit that it protrudes and falls off into the seashore mud. This works well for the mangrove, but it would be ruination in most plants. It may also be that after the ripening of the fruit and the withering of the flower there is little food available for the seeds.

In any case, it seems good sense to say that, for most plants, those kinds have succeeded whose seeds passed into a state of *arrested development.* This made it possible for the seeds to wait till the season was suitable for sprouting, or till they were sown in a suitable place. No doubt there are some seeds that usually germinate without a long rest, as in the case of willows, crucifers and grasses: but it seems safe to say that for most plants it is advantageous that their seeds should be able to lie low for a considerable time. It gives the seeds increased chances of life if there is no need for hurry, if they can simply wait for spring or until they are carried to a more suitable place. And if the embryo-plant can wait in a state of arrested development, that makes it more possible to have very protective envelopes and a very condensed and hard legacy of food.

If it be said that the embryo-plant simply has to lie low because of the hardness of the surrounding tissue and the seed-coats, and because of the unsuitable soil and weather, the answer is that this is not confirmed by the experiments of artificially removing the hard envelopes or of placing the seeds from the first in artificially hospitable conditions. Moreover, some seeds germinate best after more than one winter's dormancy. There seem to be deep advantages in a prolonged "lying low".

*Tenacity of Life in Seeds.*—Among the many errors that die hard is the sprouting of "mummy wheat". Man dearly loves a touch of the magical, and he is unwilling to give up the picturesque belief that wheat from inside a mummy-case may sprout after thousands of years of

dormancy. There is the story of the man who brought some "mummy-wheat" in Egypt and sowed it in Australia, where it germinated and grew with great vigour. There are many such "records", but in every carefully conducted scientific experiment the true mummy-wheat has refused to sprout at all. What happens in the ordinary popular experiments is the sprouting of faked mummy-wheat, that is to say, of modern seeds substituted for the ancient ones. The supply has to meet the demand; and we have heard that the alleged mummy-wheat sometimes grows into a variety that was not known in the time of the Pharaohs, but evolved in the early twentieth century! In any case, it may be safely said that if mummy-wheat germinates, it is not true mummy-wheat. So that's that.

At the same time it is certain that seeds may remain alive for many years. Thus, Becquerel proved that some seeds germinated after resting for eighty-seven years in a herbarium—a *hortus siccus* indeed. As regards the Sensitive Plant, a dormancy of sixty years has been demonstrated. In most cases, however, a tenth of that period would be considered a long dormancy; but it would be interesting to have fresh data on this subject from practical men, such as seedsmen, gardeners and farmers. Different kinds of seeds differ in their power of lying low, and much may also depend on the nature of the medium in which they lie. It has often been noticed that the redigging of a forsaken cottage-garden is followed by a reappearance of old-fashioned flowers that had not been seen there for years; but care must be taken to show that the reappearing flowers came from seeds that had been lying dormant and not from underground stems or the like which were stimulated by the exposure. Allowance must also be made for the possibility of some fortuitous fresh sowing, *e.g.*, of seeds included in the manure dug in, or of seeds carried on to the freshly dug soil by the wind, or on the feet of birds.

*Protective Husks.*—Seeds normally come to an approximate standstill in their development, being in a state of arrest when they are liberated; the quiescent state may be prolonged after sowing, sometimes for a considerable period in natural conditions or for a still longer period in experiments. Yet a little more must be said in regard to the frequent insusceptibility of seeds to untoward external influences. This is familiar in Nature, where seeds often land in very unsuitable places, such as little crevices in a wall, and yet do not die; and more striking data have been furnished by experiments—by those of Becquerel in particular.

The life of the embryo within the seed is anything but assertive, and yet it is strangely tough. One reason may be found in the seed-envelopes which allow of little diffusion as long as they are dry. Becquerel

fitted pieces of the tough seed-coats of peas and beans on the top of a tube of mercury, above a Torricellian vacuum, and found that no air was drawn through, even in the course of months. The seed-envelopes are gas-proof, as long as they are dry. When they are soaked in water, however, they show the gaseous absorption that one would expect.

In other experiments Becquerel showed that, in addition to the insulating seed-coats, there is extraordinary resisting power in seeds themselves. He perforated the envelopes of the seeds of wheat, mustard and lucerne, and subjected them to very inhospitable conditions without robbing them of their capacity for sprouting. Some of the trials which they withstood were extraordinary. He dried them in a vacuum at 40°C. for six months; sealed them up in an almost exhausted vacuum tube for a year; submitted them to the temperature of liquid air (−190°) for three weeks, and of liquid hydrogen (−250°) for three days; after which he put them on moist cotton wool—where they germinated as usual! Becquerel concluded that there was a complete cessation of the kind of activity we call "life"—which implies on its chemical side the down-breaking and rebuilding of proteins and other complex carbon compounds. It is difficult, however, to call a seed "dead" if it can eventually sprout; all that we can say is that seeds may lose all signs of life without really dying.

*Condensed Food.*—Seed-plants proved very successful in the struggle for existence, partly because what was launched on the voyage of life was already a young creature; partly because of the perfection with which the seed-coats shut out injurious influences and enabled the embryo to lie low for a long time if need be: and partly because of the legacy of condensed food which was placed at the disposal of the young plant at the critical time of germination. This food is sometimes in the embryo itself, sometimes in the embryo-sac, and sometimes in the surrounding ovule tissue: it may be large in amount as in wheat, or in small quantity as in orchids; it may be starchy, sugary, fatty or, best of all, proteinaceous; it may be softish or firm or, in rare cases like dates, almost as hard as bone. There are seeds and seeds. The most important biological facts are two: (1) that this legacy is very condensed, that it does not readily "go wrong" as long as the seed-coats are intact, but that it is fermented into fluid form before the time of sprouting; and (2) that it makes it possible for the sprouting young plant to resume development and growth until it is able to fend for itself by absorbing food from the soil and the air. If man had thought out the device of seeds, he would have been very proud of his invention!

*The Evolution of Seeds.*—We have left this question to the end,

because even an outline of an answer is undeniably difficult ; but it is well worth while to try to get hold of the clue. For many millions of years after plants began there were no seeds, the first seed-bearing plants making their appearance in the Upper Devonian Period amid the ferns and other plants of the flowerless forests. If we ask how there could be successful plants without any seeds, we may get the beginning of an answer if we take a withering fern-frond and shake it over a sheet of paper and notice the shower of "spores", which used to be called "fern-seed". These spores, however, are very different from seeds, being single cells, as light as air, whereas seeds are already embryo-plants.

It is impossible, however, to stop here, for if we are able, *e.g.*, in a green house, to watch a spore that sinks on to the moist soil we can see that it developes into a minute green disc, often about half the size of a three-penny piece. This inconspicuous disc or prothallus is actually the sexual fern—in great contrast to the asexual or spore-bearing fern with which everyone is familiar. On the under-surface of the disc there are minute male and female reproductive organs, and as is usual among living creatures, the egg-cell is fertilized by a sperm-cell and begins to develop into an embryo-plant, although this does not form a seed in ferns or in any of their (cryptogam) allies. In ferns it grows up from the prothallus and gradually developes into the spore-bearing fern-plant. This is what is called "alternation of generations"—the alternate occurrence in one life-history of two different forms differently produced. In the fern life-history the sequence is : Spore-bearing Fern—Spore—Prothallus—Egg-cell and Sperm-cell—Embryo—Spore-bearing Fern. In this, however, there is nothing quite comparable to a seed.

It was not till about 1850 that botanists saw how to relate the ordinary flowering plants to the flowerless forms like ferns and horse-tails, mosses and club-mosses. It was then that a genius, Wilhelm Hofmeister, had the insight to discern and the skilled patience to prove that the ordinary flowering plant is a spore-bearer, that has incorporated and well-nigh suppressed the sexual generation.

It is a difficult story, but a beautiful one, that the stamens and carpels of the flower are transformed spore-bearing leaves, that there are two kinds of spores—the pollen-grains made in the anther and the embryo-sac that is hidden away inside the ovule within the ovary. As far as the pollen-grain is concerned, the sexual generation (like a fern's prothallus) is restricted to the formation of three nuclei, one of which fertilizes the egg-cell. As far as the embryo-sac is concerned, the sexual generation (again like the fern's prothallus) is restricted to three-cell-divisions in the embryo-sac, one of them resulting in an egg-cell.

From the fertilized egg-cell an embryo-plant developes, surrounded by more or less nourishment, while the outer walls of the ovule result in the protective envelopes. Thus we account for seeds, which began to be formed in certain extinct pioneering plants, many millions of years ago. The pioneer seed-bearers made their appearance in the Upper Devonian, as we have said, and became exuberant in the Carboniferous Period, when the coal-measures were laid down. They are called Seed-Ferns, or Pteridosperms or Cycadofilices, the last name meaning that they show a combination of Cycad-like and Fern-like characters. They make one of the most important steps in the whole story of evolution. Where would Man be without seeds!

We are not pretending that it is at present possible to describe the precise steps by which the first seeds began millions of years ago, but Hofmeister discovered the main clue—that the spore-bearing generation incorporated a dwindling sexual generation ; and Professor Bower has discovered another clue, that the ascendency of the asexual "sporophyte" and the dwindling of the sexual "gametophyte" is to be associated with increased adaptation to terrestrial conditions. Dry land does not afford such a safe and soft cradle for egg-cells and embryos as the water does. Hence the great advantage of well-mothered seeds, which are not set adrift till they are relatively advanced.

Moreover, the fertilizing elements—the male-cells—of ferns and their allies are active ciliated cells, able to reach the egg-cell by swimming in water-containing spaces, *e.g.*, under the prothallus. But how difficult this would be in ordinary flowering-plants—a difficulty evaded by having insect-carried or wind-borne pollen-grains that adhere to the moist stigma of the flower, and send out a long pollen-tube feeling its way down the style towards the distant egg-cell in the embryo-sac. The fertilizing male element in the flowering plant is a nucleus that travels down the pollen-tube.

The long story should become vivid when we notice the remarkable discovery that out of the pollen-grain of Cycads and the Maiden's Hair Tree there come two or more motile spermatozoa or male-elements, very like those of ferns and their allies. We give flowering plants the technical name of Phanerogams, which means "with conspicuous sex", in contrast to Cryptogams "with hidden sex". The fact of the matter is that in flowering plants the whole of the true sex-generation has been so thoroughly hidden away that it needs a botanist to find it. But it was this that led to seeds.—*The Journal of the Ministry of Agriculture*, Vol. XXXVII, No. 9.

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FIG. 1.—Map of Java. The areas have been marked off according to the number of rainy days in the four dry months of the year. The map has been adapted from one prepared by the Imperial Meteorological Bureau.